Lake St. Clair Coastal Habitat Assessment:

with recommendations for conservation and restoration planning

Great Lakes Commission 2006

Acknowledgements

This document is the result of a collective effort of dozens of individuals represented by a Project Management Team comprised of nearly 30 different stakeholder groups from around Lake St. Clair (see Appendix A).

Special thanks go to Susan Campbell for her tireless research and writing, particularly on Sections IV (terrestrial ecosystem and habitat types), V (System Stressors and Responses) and VI (Overarching Responses to Stressors); her copious excellent photographs; and general coordination of the entire document and the parallel web site at http://www.glc.org/habitat/lsc.

In addition, appreciation is extended to the following individuals:

- Dora Passino-Reader, Sandy Morrison and Burke Greer of the U.S. Geological Survey Great Lakes Science Center for writing significant text related to aquatic ecosystem and habitat types and generating maps depicting stressors on aquatic habitats;
- Bill Parkus of the Southeast Michigan Council of Governments for his contributions regarding planning in the U.S.;
- Ernie Kafcas of the Michigan Department of Natural Resources and Mark Richardson, formerly of the Macomb County Prosecutor's Office for their contributions to case studies; and
- Dave Kenaga of the Michigan DEQ for his diligent commitment to reviewing this document in its many iterations as a member of the Project Management Team.

Layout and design is credited to a team of individuals at the Great Lakes Commission, including Shannon Glutting, Devra Pollack and Elizabeth Schmidt.

A subset of the Project Management Team with representation from the Great Lakes Commission, NOAA Coastal Services Center, Michigan Natural Features Inventory and Walpole Island First Nation had significant roles and responsibilities in numerous sections of the document. Those individual include: Victoria Pebbles, Thomas Rayburn, Beth Johnson and Dave Knight of the Great Lakes Commission, John Paskus of the Michigan Natural Features Inventory, Alyssa Olsen Callahan of the NOAA Coastal Services Center, and Dave White of Walpole Island Heritage Centre.

Funding for this project was made possible through a cooperative agreement between the Great Lakes Commission of Ann Arbor, Michigan and the National Oceanic and Atmospheric Administration's Coastal Services Center of Charleston, South Carolina. The project manager was Victoria Pebbles.

Lake St. Clair Coastal Habitat Assessment:
with recommendations for conservation and restoration planning

Table of Contents

Lake St. Clair Coastal Habitat Assessment:

with recommendations for conservation and restoration planning

Table of Figures

Lake St. Clair Coastal Habitat Assessment:
with recommendations for conservation and restoration planning

Executive Summary

Nearly all the coastal wetlands and other natural habitat that historically surrounded Lake St. Clair has been degraded or lost as industry, urbanization, commercial agriculture and suburban development have reshaped the landscape. These and other forces are expected to continue to transform the area.

From 2002 to 2005, the Great Lakes Commission led a Lake St. Clair project focused on providing information and tools to guide future development and planning for the conservation and restoration of the area's coastal habitat. In so doing, this project addressed several priorities in both the Great Lakes Basin Compact – the Commission's founding document – and its strategic plan, including the call to "collect, analyze and interpret baseline data and information on natural resources and environmental conditions for use by Great Lakes-St. Lawrence researchers, managers and policymakers."

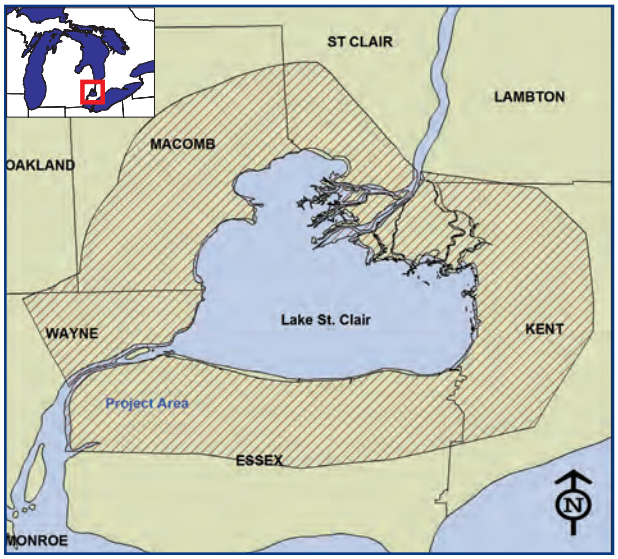
Study Area

The primary study area consisted of the islands of the St. Clair River delta and a 10-mile buffer surrounding Lake St. Clair, including parts of Detroit, Windsor, and six counties in Michigan and Ontario. This area covers 752,555 acres (304,548 hectares) or 1,176 square miles (3,046 square kilometers), representing nearly 20 percent of the total watershed.

All the natural communities that originally bordered the lake are within the study area, including those presently at greatest risk from the impacts of human activity, as well as many found further from the lake, which are characteristic of the larger watershed. The study area was chosen in part because of the availability of consistent digital data, which was provided by the National Oceanic and Atmospheric Administration (NOAA) Coastal Services Center through its Coastal Change Analysis Program.

Project Structure

This project was spearheaded by the Great Lakes Commission, which served as the principal investigator and project manager. However, the real success of the project lied in the significant partnerships and cooperation that brought multiple agencies and organizations together to focus on a common issue.



The Commission established three groups to facilitate cooperation at different levels. First, a core group was responsible for day-to-day data collection, research, and analysis, and the ultimate development of four characterization products, described below. This group included the Great Lakes Commission, the NOAA Coastal Services Center, the Michigan Natural Features Inventory (MNFI), and Walpole Island First Nation (WIFN).

The real success of the project lies in the significant partnerships and cooperation that brought multiple agencies and organizations together to focus on a common issue.

Second, a project management team helped in the development of all tools and information and ensured that the final products met the needs of the larger user community, which the team represented. This team included 35 representatives from nonprofit organizations, academic institutions, and federal (U.S. and Canadian), state, provincial, tribal, regional and local agencies. Finally, the project had an advisory committee, which included additional stakeholders with a broad array of interests in Lake St. Clair. Several team members – such as the Southeast Michigan Council of Governments, U.S. Geological Survey, and Michigan Department of Natural Resources – demonstrated outstanding collaborative spirit by engaging directly in data gathering and analysis, writing and other tasks.

Funding for the project was provided by NOAA under a cooperative agreement awarded to the Great Lakes Commission, which contracted with MNFI and WIFN.

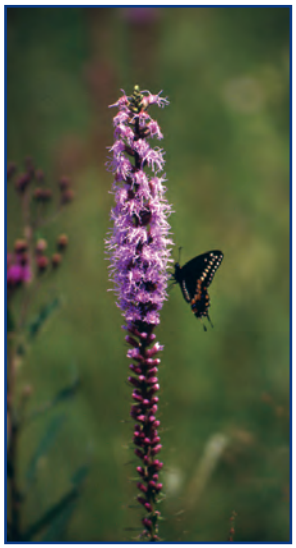


Photo credit - Suzan Campbell

Swallowtail butterfly and liastris plant.

Project Products

The Lake St. Clair coastal habitat project yielded four products to support coastal resource management:

- **Project Web Site (www.glc.org/habitat/lsc) which links to the other three products**
- **GIS Database**
- **Integrated Coastal Management (ICM) Decision-Support Tool** (described in section VII-B of this Assessement)
- **A Coastal Habitat Assessment, with Guidelines and Recommendations for Conservation and Restoration Planning**

Coastal Habitat Assessment

This Coastal Habitat Assessment synthesizes ecological, political and socioeconomic data for the 10-mile buffer area around the lake, as well as information that reflects conditions of the entire watershed, drawing from existing literature and new data collected during the course of the project.

This broad, interdisciplinary approach is important for at least three reasons. First, the political context is complex – jurisdictions represented within the project area include the governments of Canada and the United States, Walpole Island First Nation, the province of Ontario, the state of Michigan, six counties, 14 watersheds, and hundreds of cities, towns, villages and unincorporated areas, as described in Section II-A.

Second, the socioeconomic factors driving habitat loss must be understood before any conservation and restoration efforts can be undertaken. These socio-economic forces are described in Sections II-B through II-D, beginning on page 20. In the portion of the study area that lies in Michigan, for example, habitat loss is driven primarily by urban and suburban development. Declines in the number of persons per household and the declining density of development as people migrate from urban to suburban neighborhoods magnifies the impact of population change on the landscape.

Photo credit - Dave Kenaga

Project management team members Dave White and Suzan Campbell examine the flora of an oak savanna.

In Ontario, however, development is concentrated in the Windsor metropolitan area. Southwest Ontario is the province's agricultural heartland, and most habitat loss in this part of the study area is attributable to agriculture. Although Essex County contains the most urbanized areas within the Ontario portion of the project area, 92 percent of its land is in agricultural uses, including cultivated lands, pastures and hayfields.

Third, an understanding of natural processes and the natural communities that they shape is essential to effective restoration and conservation planning. This Coastal Habitat Assessment provides an overview of the natural communities that were present historically within the project area and detailed descriptions of those habitats that remain today (Sections III and IV). Although the region has been altered dramatically in the last 300 years, it is home to several globally imperiled natural communities: lakeplain prairie, lakeplain oak opening or savanna, and Great Lakes marsh, as well as a number of protected (rare or endangered) species.

Photo credit - Suzan Campbell

Lake Plain Prairie

Profiles of particular plants, animals and natural communities are included in the Assessment and are also accessible from the project web site. These abstracts, produced by MNFI and Walpole Island First Nation, feature important information about the distribution, threats, biology, and conservation and management needs of each species or habitat type (See www.glc.org/habitat/lsc/abstracts).

Other important features of this Coastal Habitat Assessment include

- a comprehensive compilation of specific coastal habitat threats, along with strategies to improve conservation and restoration (Section V);
- identification of programs and technical resources for public and private landholders, with case studies describing successful projects (Section VI-A);
- descriptions of inventory, monitoring, and planning tools for conservation and restoration (Sections VI-B, VI-C and VII); and
- guidelines and recommendations for conservation and restoration planning (Section VIII).

The guidelines and recommendations of the Coastal Habitat Assessment reflect the latest scientific and GIS data, and thus are critical for conservation and restoration planning. The priority conservation analysis provided in this document is essentially a static report, but the processes used to create it have been incorporated into the ICM tool so that local land managers can bring new data into their conservation planning efforts.

Together, this Lake St. Clair coastal habitat assessment and other project products offer state-of-the art tools for resource managers to engage in local project planning that complements the larger system of conservation and restoration areas. Using this integrated approach, individual projects can meet local needs and priorities, while maximizing benefits to the ecosystem. These products enable decision making that recognizes the value of the lake's coastal resources to sustainable development.

An analysis performed by the Michigan Natural Features Inventory identified Potential Conservation Areas, or PCAs, around Lake St. Clair that are dominated by natural vegetation or possess unique natural features and have potential for conservation and restoration. The PCA analysis can be used by local municipalities, land trusts, and other agencies to prioritize conservation efforts and to support the establishment of a linked system of natural areas around Lake St. Clair.

Lake St. Clair Coastal Habitat Assessment:
with recommendations for conservation and restoration planning

Preface

This Assessment is one of several products that came out of a two-year cooperative effort focused on Lake St. Clair's coastal environment. Other products include maps, an integrated coastal management decision support tool and a web site that features all of this information.

The Lake St. Clair Coastal Habitat Assessment brings together the most recent data and information from the U.S. and Canada about the habitats surrounding Lake St. Clair, with a focus on natural habitats, or natural communities. A natural community is a distinct grouping of plants and animals that live together in a common habitat. The habitats discussed in this document are considered natural if they are not classified as developed or agricultural lands. Although most have been altered since European settlement, they are natural in that they currently support or can be readily restored to support indigenous plant and animal populations. This assessment documents the extent, qualities and features of Lake St. Clair coastal habitats, including some of the key species that inhabit them. It also discusses significant habitat stressors and the existing programs and policies intended to mitigate them. Data and knowledge gaps are identified to direct future research efforts. Several new tools have been developed, which incorporate the latest GIS data to identify potential conservation areas and provide guidelines and recommendations for restoration and conservation. Discussed in Section VII, these tools serve as a companion to this document, to implement additional measures necessary to conserve and restore important habitats. They may also be useful in filling some of the identified information gaps.

> **FACT**
> A natural community is a distinct grouping of plants and animals that live together in a common habitat.

Lands that have been altered by human development are also documented and discussed. Understanding human development patterns is critical to mitigating or preventing the negative impacts of development and anticipating needs for habitat conservation and restoration. Finally, this document focuses on a 10-mile stretch of land around the lake, for which unified land cover data are available. The project area includes examples of all of the natural communities which originally bordered the lake, including those that are presently at greatest risk from the impacts of human activity, as well as many found further from the lake.

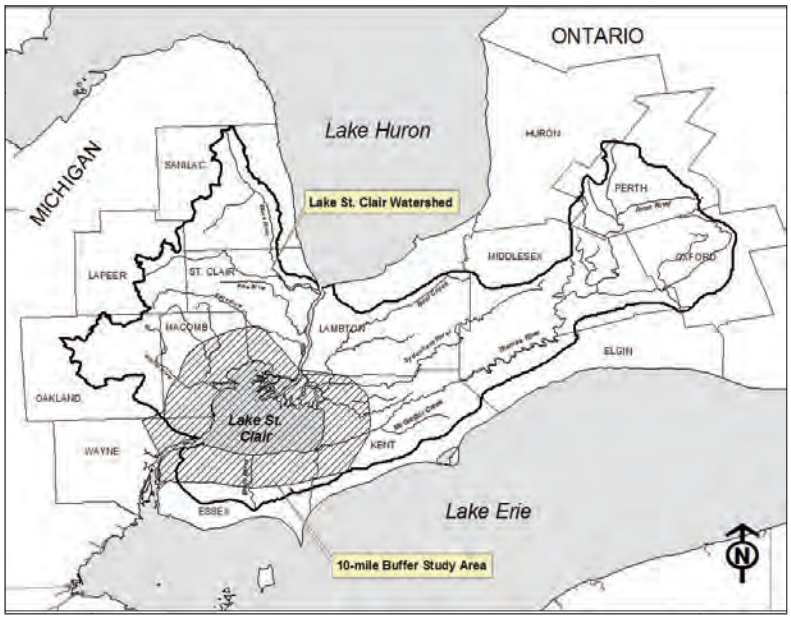
> **HIGHLIGHT**
> The full text of this document is available online at www.glc.org/habitat

Section I. Background

Focus on Lake St. Clair: from "Forgotten Lake to Heart of the Great Lakes".

The Lake St. Clair Coastal Habitat Project grew out of an array of initiatives beginning in the mid-1990s to focus specifically on Lake St. Clair, which had been dubbed "the forgotten lake." Although Lake St. Clair was technically part of the

Lake Erie Lakewide Management Plan (LaMP), high profile pollution problems in Lake St. Clair, such as beach closures due to elevated bacteria levels and dead fish on beaches prompted public outcry. The evidence and political support was growing: Lake St. Clair needed its own plan and programs on par with the five Great Lakes[1]. Local, state and federal officials responded. In the Water Resources Development Act of 1999, the U.S. Congress authorized the U.S. Army Corps of Engineers to lead the development of the Lake St. Clair-St. Clair River Management Plan (referred to in this document as The Management Plan). Congress provided limited funds and a deadline. The Great Lakes Commission (GLC) was contracted to coordinate the development of the Management Plan. The Management Plan provides a framework for managing Lake St. Clair as a natural resource. There was also recognition that certain resource management issues, such as coastal habitat, could benefit from more in-depth data collection and analysis.



This habitat assessment responds to the Lake St. Clair Management Plan's recommendation for "a habitat strategy to protect, restore and maintain natural physical and biological diversity and identify priority habitat areas for restoration and conservation." In particular, this assessment responds to most of the suggested elements of such a habitat strategy, including:

- Provide a single coordinated inventory of wetlands and other habitats that identifies protected and managed habitats as well as rare and environmentally sensitive habitats
- Locate, inventory and map imperiled species
- Develop outreach tools...highlight programs that increase interest in, and awareness of, habitat restoration and conservation.....focus on the unique habitat within the watershed and methods to protect it
- Encourage local units of government to preserve and protect unique habitat areas and to restrict development in environmentally sensitive areas
- Provide technical assistance to local units of government to manage local habitat areas

HIGHLIGHT

This habitat assessment responds to the Lake St. Clair Management Plan's recommendation for "a habitat strategy to protect, restore and maintain natural physical and biological diversity and identify priority habitat areas for restoration and conservation."

The Management Plan further acknowledges the coastal habitat project by recommending that stakeholders "use the findings of the Lake St. Clair Coastal Habitat Restoration and Conservation Plan to contribute to a Lake St. Clair habitat strategy."

A parallel process is being undertaken as part of the Lake St. Clair Canadian Watershed Management Plan to develop recommendations that will be implemented from the Canadian side. A Draft *Lake St. Clair Canadian Watershed Technical Report* has been prepared and will undergo public review and comment after which a series of recommendations will be developed. This document is intended to serve as the basis for a uni-

fied binational approach to coastal habitat conservation and restoration around Lake St. Clair that builds on the two management plans.

I.A. A Regional Partnership Approach

The Lake St. Clair Coastal Habitat Project

Landscape Characterization and Restoration (LCR) program. The LCR program calls for developing a digital information resource to help coastal resource managers make resource management, regulatory and/or land use planning decisions. The Great Lakes Commission consulted with multiple Lake St. Clair stakeholders who supported the concept of a partnership approach and focus on Lake St. Clair coastal habitat.

> **HIGHLIGHT**
>
> The purpose of the project was to characterize, assess and identify needs and strategies for the conservation and restoration of Lake St. Clair Coastal habitat.

In 2002, the Great Lakes Commission, in partnership with the U.S. National Oceanic and Atmospheric Administration Coastal Services Center (NOAA-CSC: *www.csc.noaa.gov*) and the Michigan Natural Features Inventory (MNFI – a program of Michigan State University Extension: *http://web4.msue.msu.edu/mnfi*) formed a partnership to collect, compile and analyze data and information related to Lake St. Clair. Walpole Island First Nation joined that formal partnership in early 2004. Funding was provided by the NOAA-CSC's Landscape Characterization and Restoration Program (*www.csc.noaa.gov/lcr*). The purpose of the project was to characterize, assess and identify needs and strategies for the conservation and restoration of Lake St. Clair Coastal habitat. The collective effort is known as the Lake St. Clair Coastal Habitat Project.

The project called for the development of several integrated components to achieve this goal:

- A draft coastal habitat restoration and conservation plan
- A web site that features this draft coastal habitat plan, maps, decision-making tools, and information about Lake St. Clair coastal habitat
- An Integrated Coastal Management (ICM) tool for evaluating the impacts of various land use and management decisions on Lake St. Clair coastal habitat

The project was administered through a multi-tiered partnership approach featuring a Project Management Team, a Project Advisory Committee and a Core Group. A Decision Support Working Group was also established to guide the development of the ICM tool.

A Project Management Team (PMT) was formed including federal, state, provincial, tribal/First Nation and local governments, non-profit organizations and academic institutions with a significant responsibility for or interest in Lake St. Clair coastal habitat (Appendix A). The PMT provided information, feedback and leadership in developing all project products.

The Lake St. Clair Coastal Habitat Project Advisory Committee provided an opportunity for interested stakeholders to participate and provide feedback with less direct responsibility The Advisory Committee was provided with periodic updates on products and meetings, but did not have an active role in specific tasks or their outcomes (Appendix B).

At the core of the PMT were several agencies and organizations that were responsible for the day to day project work and coordination. The Great Lakes Commission was the project coordinator and secretariat to the PMT with lead responsibility for developing the habitat assessment and web site. NOAA-CSC was the lead on developing the Integrated

HIGHLIGHT

Detailed descriptions of many of the animal, plant and natural communities were developed for the project and are available online at www.glc.org/habitat/abstracts.html

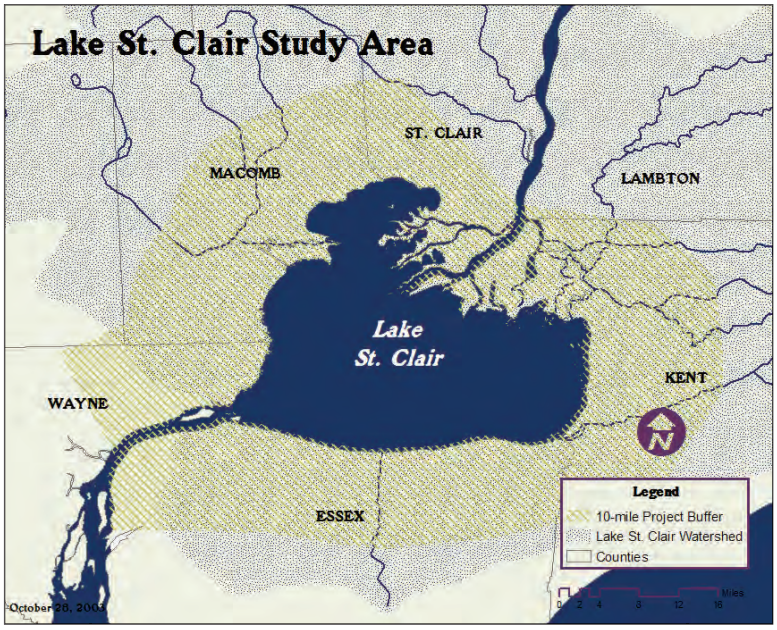
Coastal Management Tool, including testing the tool and outreach. MNFI applied considerable ecological expertise, leading the efforts to analyze information about unique, rare or endangered species and natural communities and their surroundings and identify and map areas that have high conservation and restoration potential. Walpole Island Heritage Centre provided written materials characterizing their portion of the project area and habitat management challenges to incorporate into this document. MNFI and the Walpole Island Heritage Centre each also developed a series of detailed abstracts that feature information about rare, unique or endangered species and natural communities that exist in the project area, which complement many that had already been developed by MNFI, and are linked to the project website. Animal, plant and community abstracts for all of Michigan as well as the project area can be found at MNFI's website at *http://web4.msue.msu.edu/mnfi/pub/abstracts.cfm*

Habitat assessment

This coastal habitat assessment has been developed to serve as the basis for a binational unified approach to coastal habitat conservation and restoration within the larger framework of the U.S. and Canadian Lake St. Clair Management Plans. This document supports those efforts by providing more detailed and coordinated data and information about the Lake's coastal environment and offers new tools to more effectively manage the coastal habitat component of the Lake. The information within this document is based on the best available data to date (mid-2004) and has undergone multiple reviews by managers and experts from around Lake St. Clair. Rather than a prescription of what to do or not to do, this assessment offers detailed scientific and socioeconomic information about the area's coastal habitats and the conservation and restoration of those habitats. State and local governments as well as organizations with land and/or habitat management responsibilities can use this assessment to develop a more comprehensive planning approach for conserving local habitat areas.

Project Study Area

The study area encompasses a roughly 10-mile buffer landward from the water's edge around the lake. One of the first questions that arose was "What does coastal mean?" "How far inland and out into the lake shall we go?" Coupling the topical focus on the coast with the method's focus on digital data compilation helped to define the geographic scope of the project as that portion of the coastal area for which there was consistent data on both sides of the border. That data source was land cover data provided through NOAA's Coastal Change Analysis Program (C-CAP: *www.csc.noaa.gov/crs/lca/ccap.html*), which provided land cover and change data for the U.S. coastal zone. C-CAP data existed for the entire Lake St. Clair watershed on the U.S. side, but not on the Canadian side. In support of this project, NOAA was able to modify an existing contract to get C-CAP data for Michigan to include a portion of Canada around Lake St. Clair. The contractor was able to cover a 10-mile buffer on the Canadian side of the Lake. As a



result, the project was able to obtain land cover and change data for Canada that complemented data already available on the U.S. side. Project partners agreed that the 10-mile buffer area would be the scope of the project study area on both sides of the lake[2]. It should be noted that the buffer is roughly 10 miles; it is not equal on all sides of the Lake. Results from analysis of the C-CAP data, such as extent of land cover types, and land cover change are incorporated within relevant sections of this document. A more detailed discussion of C-CAP products and their application in this project is included in Section VII. A.

HIGHLIGHT

The study area encompasses a roughly 10-mile buffer landward from the water's edge around the lake.

This project builds on watershed-scale efforts already underway (e.g., the U.S. and Canadian Management Plans) and offers a focused examination of the coastal element of the ecosystem where the pressures and impacts of degradation from activities throughout the watershed are most keenly experienced. The 10-mile project area around the lake includes 752,555 acres (304,548 hectares) or 1,176 square miles (3046 square kilometers), representing 19 percent of the total watershed. Covering nearly one fifth of the watershed, this area includes examples of all of the natural communities which originally bordered the lake including those presently at greatest risk from the impacts of human activity, as well many found further from the lake, which are characteristic of the larger watershed.

I.B. Overview of Socio-Economic History of Lake St. Clair

In many ways, Lake St. Clair is a microcosm of the larger Great Lakes Basin. The Lake and its surrounding watershed are shared by two countries and one First Nation. Fourteen counties are wholly or partly in the Lake St. Clair watershed, six of which border the lake itself: Macomb, Wayne and St. Clair counties on the U.S. side and Essex, Kent and Lambton on the Canadian side. More than 3 million people (3,029,237)[3,4], reside in the coastal counties on the U.S. side and 1,125,566 reside in the Canadian coastal counties. More than 700 cities, towns, villages and named unincorporated areas are located partially or wholly within the Lake St. Clair watershed, which is home to about 2,957,000 residents[5]. A subset of the watershed, the 10-mile coastal buffer project area includes approximately 201 cities, towns, villages and named unincorporated areas and is home to approximately 1.7 million residents on the U.S. side alone.

FACT

In the late 1700s and early 1800s land surveyors documented that the land around Lake St. Clair was primarily deciduous forest with some tallgrass (lakeplain) prairie and large areas of wetlands that included forested swamps.

The region's earliest residents likely had marginal impacts on the Lake St. Clair watershed, although use of fire as a management tool did alter the landscape favoring prairies, savannas and open forests that were conducive to hunting and farming. European traders arrived in the area in the 1600s and although they significantly impacted native populations through disease, displacement and warfare, they did little to modify the landscape[6]. In the late 1700s and early 1800s land surveyors documented that the land around Lake St. Clair was primarily deciduous forest with some tallgrass (lakeplain) prairie and large areas of wetlands that included forested swamps.

The U.S. portion of the Lake St. Clair watershed was initially settled by Europeans because the St. Clair River and Lake St. Clair provided numerous resources, including a transportation corridor and an abundance of fish and wildlife. Expansive hardwood forests around the lake allowed the settlers to harvest timber and use the lake and associated rivers to the north and south to float logs and ship lumber. In fact, the first sawmills of the Northwest Territory were located

on the St. Clair River and its tributaries with at least eight built before 1800[7]. It is believed that there was a sawmill on the St. Clair River as far back as 1690[8]. The first steam sawmill in the Northwest Territory, the Black River Steam Mill, was built on the north bank of the Black River in 1832 in what is today Port Huron[9]. These sawmills played a significant role in early development along the Great Lakes. For example, the pine timber used to build the Citadel in Detroit is believed to have come from Patrick Sinclair's sawmill on the Pine River. The Ignace Morass mill, located on the Black River, supplied the US Government with spars and ship timbers during the war of 1812, and lumber from the Ai Beard mill at Ruby supplied the lumber to build the city of Milwaukee, Wisconsin[10]. In 1869, more than 64 million feet of logs floated down the Black River alone[11]. The lumbering era reached its peak in the St. Clair River area in the late 1870's, and forests were logged until they were depleted.

The timber industry ultimately and literally cleared the way for subsequent agricultural development. In the late 1700s, permanent settlements began altering the land for agricultural practices and residential development. Throughout the 1800s settlers changed the land from primarily deciduous forests and lakeplain prairies into agricultural land. Approximately half of Harsen's Island was diked by the late 1800s[12] and by the early 1900s most of the forest, swamp and prairie lands around Lake St. Clair were converted into a rural agricultural landscape. Drainage of wetlands to develop agricultural land and build roads significantly modified the hydrology of the landscape, and thus the types of natural communities that it supported. Wetland destruction or modification was legally sanctioned by governments on both sides of the Lake. In particular, the U.S. Swamp Lands Act of 1850 encouraged wetlands to be drained and converted to agricultural or other "useful" purposes.

FACT

By the early 1900s most of the forest, swamp and prairie lands around Lake St. Clair were converted to agricultural uses. Wetland destruction was legally sanctioned by governments on both sides of the lake and the U.S. Swamp Lands Act of 1850 encouraged wetlands to be drained for "useful" purposes.

In addition to agriculture, other economic forces were an important part of Lake St. Clair's history. From the 1840s through the U.S. Civil War, a ship building industry existed in the St. Clair River Delta in the northern part of the lake. In the mid-1860s, both the Toledo and Detroit salt companies exploited the shallow evaporite bedrock beneath the St. Clair River bank for halite. During this period, Great Lakes shipping utilized the North Channel of the river because this channel was the deepest. Anchor Bay received its name from the ships that anchored there while waiting for their cargo to be lightened for transit over the bar of the North Channel. The transferring of cargo furnished employment for a large percentage of the people living along the Lake St. Clair shoreline.[13]

The Lake's historic role as a transportation corridor expanded in the 1800s with passenger ships, which, coupled with railroads, improved access to the region and aided the expansion of urban settlements and recreational facilities along the lake. By the 1870s, the development and gradual improvement of transportation routes also had a significant impact on the landscape. An electric railway was constructed along the shoreline of Lake St. Clair from Detroit to Algonac and north along the river to Port Huron[14]. The railway was built right through St John's Marsh. In 1873, a channel a little more than 19 feet (6 meters) deep was dredged through the delta's South Channel to avoid shipping delays caused by the sand bar at the mouth of the delta's North Channel[15]. Finally, on the Canadian side, the Lake Erie and Detroit River Line was constructed along the east bank of the St. Clair River joining Sarnia and Port Lambton, Ontario to other agricultural communities in southern Ontario. In addition, the Grand Trunk Railway linked the villages of Stoney Point and Belle River to Windsor, Ontario[16].

Major dredging began about 1855, establishing a commercial navigation channel through the lake in a northeast-southwest direction from the St. Clair Delta to the Detroit River[17]. This dredging increased its maximum natural depth of 21 feet (6.4 meters) to its current depth of 27.2 feet (8.3meters).

In 1858, the world's first commercial oil well was drilled in Lambton County, prompting an oil boom in the region that spurred expansion of railway and shipping industries. Oil production and enhanced transportation networks also enhanced Canada's agricultural industry around Lake St. Clair[18]. Oil production has since declined significantly, but the oil industry remains an important economic driver in this part of Lake St. Clair.

As transportation improved access to the delta, more people started to farm along the northern portion of Lake St. Clair and build small cottages on the islands in the delta. To accommodate this development, natural levees were modified by bulkheading (particularly along the South Channel) and filling on the river shoulders, crevasses and edges of deep water bays. In addition to farms and small cottages, several fishing and hunting clubs were established on both sides of the Lake during the 1870s. Five clubs were located on the U.S. side and two on the Canadian side, all but one of which were located on the improved South Channel. Later, resort hotels developed, primarily on the US side. The presence of hunt clubs, hotels and cottages built on backfill and stilts with waterways as the main mode of transportation led to the nickname "Little Venice".[19]

FACT

As the St. Clair River enters Lake St. Clair, the delta divides flow from the St. Clair River into three main channels and several secondary channels, which create numerous islands, commonly known on the U.S. side as the St. Clair Flats.

In 1886, the U.S. Congress authorized the deepening of the Clinton River to 7.9 feet (2.4 meters) and Lake St. Clair and the St. Clair Flats South Channel to 27.6 feet (8.4 meters). Deepening of the Delta's South Channel enabled excursion boats to operate more readily between Detroit and the Flats and tourism in the Flats area blossomed. By the 1890s there were multiple companies with passenger vessels serving the area.[20]

Around the 1900s and particularly on the U.S. side, highway and road construction began to facilitate low-density residential and commercial development. Most urban centers were established strategically in areas that had access to water for transportation and power. The availability of marine transportation aided in the expansion of the petrochemical industries along the St. Clair River to the north. As transportation modes evolved, rail lines and major roads connected the urban communities that had become established based on their proximity to the lake. This urbanization intensified significantly after World War II and by the mid-1970s, much of Michigan's shoreline of Lake St. Clair was developed into homes and small businesses. The Canadian landscape around Lake St. Clair was spared the rapid post-war urbanization, leaving most of the land around the lake in agriculture. This is likely due to the significance of southern Ontario for Canada's agricultural productivity.

Lake St. Clair was a natural place for the establishment of commercial fishing, which was an important industry until the 1900s when overfishing caused the decline of fish populations in Lake St. Clair and eventually the close of the Michigan commercial fishery in 1908. All commercial fishing was closed in 1970 due to the presence of mercury in fish. In 1980, with reduced levels of mercury contamination, the commercial fishery was reopened in Ontario using permits and quota allocation, although no permits for walleye were allocated. Financial returns were poor, however, and today, commercial fishing on Lake St. Clair is limited to a small baitfish industry in Ontario and a few traditional native commercial licenses within Walpole Island First Nation.

Today, the lake is an important binational resource, providing numerous benefits to the nearly 3 million people that reside within its watershed. Industries once based on extraction or consumption of natural resources have mostly been replaced by recreation and tourism so that residents and the millions of tourists who visit Lake St. Clair every year can enjoy activities such as fishing, swimming, boating, hunting and bird-watching. Section II contains a more detailed discussion of the Lake's social and economic characteristics today.

I. C. Overview of Natural History of Lake St. Clair

Lake St. Clair and the surrounding lands in the project area lie within the former lake bed of Lake Maumee, an early proglacial lake that formed from meltwater along the front of a Pleistocene glacier. As the ice front retreated and then readvanced, and water levels fluctuated, Lake Maumee was the first of a series of lakes that covered huge areas including Lake Erie, Lake St. Clair and parts of southeastern Michigan, northern Ohio and southern Ontario. Initially, these lakes drained westward into the Mississippi by various routes, and then eventually east, ultimately draining via their present route into the Atlantic Ocean[21] (See Figure I. C. - 1).

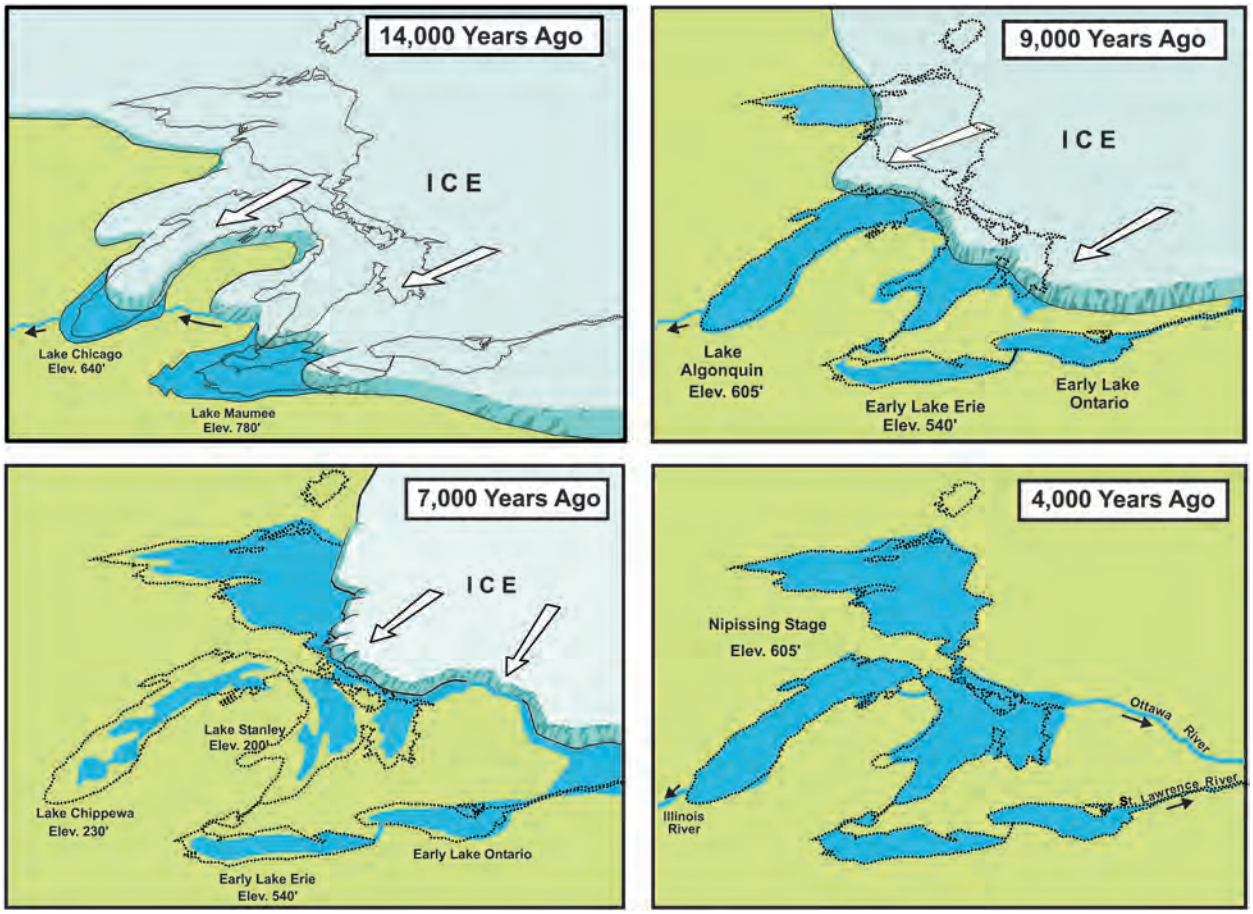


Figure I. C. - 1
From: "Living with the Lakes" (GLC & ACOE, 1999)

As the water levels dropped, huge areas of former lake bottom were exposed. The exposed lands, or lakeplains, are broad, flat plains formed by the fine sediments that collected at the bottom of glacial lakes. The Maumee lakeplain is a flat, clay lakeplain dissected by broad glacial drainageways of sandy soil and beach ridges from the shores of former Lake Maumee[22]. In Ontario, the lakeplain in the Canadian portion of the project area is referred to as the St. Clair Plain[23].

FACT
Lakeplains are broad flat plains formed by the fine sediments that collected at the bottom of glacial lakes.

The Lake St. Clair we know today has an area of 430 square miles (1,115 square km) with a total shoreline length of 169 miles (272 km) including the delta shoreline. Its average depth is only 12 ft (3.7 m) with a maximum natural depth of 21 ft (6.4 m). It is connected to

Lakes Michigan and Huron to the north via the St. Clair River and to Lake Erie to the south via the Detroit River. Lake St. Clair receives 98 percent of its water from the upper Great Lakes (Huron, Michigan, Superior) and as such, serves as an outlet for the upper Great Lakes. These lakes have a combined drainage basin of 146,600 sq mi (379,800 sq km). From this standpoint, the entire upper Great Lakes is part of the Lake St. Clair watershed. From another standpoint, the Lake St. Clair watershed includes the collective watersheds of the six major tributaries that drain into the St. Clair River and/or Lake St. Clair plus associated lands that drain directly into the lake. These include the Clinton, Belle, Pine and Black Rivers on the U.S. side and the Sydenham and the Thames Rivers on the Canadian side. The Belle, Pine and Black Rivers drain into the St. Clair River first. The Lake St. Clair watershed covers 3,927,175 acres (1,589,270 hectares) or approximately 6,136 square miles (15,893 square kilometers) of land. The project area covers 1,176 square miles (3046 square kilometers) or 19 percent of the total watershed (See Figure I. C. - 2).

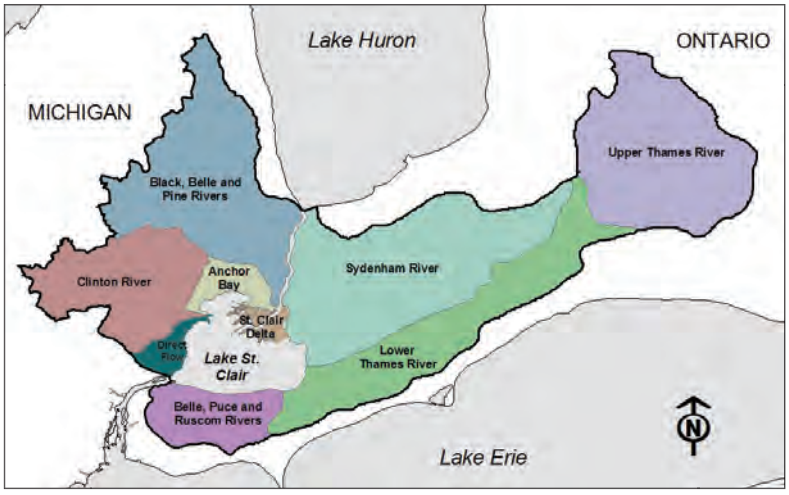


Figure I. C. - 2
Watersheds that drain into Lake St. Clair

HIGHLIGHT
The St. Clair Delta is one of the largest freshwater deltas in the world and is of continental significance to hundreds of thousands of migratory waterfowl, shorebirds and songbirds.

The St. Clair River slows suddenly as it enters the wide, shallow Lake St. Clair. This deceleration, combined with abundant suspended sediments that the river brings from Lake Huron, has formed the St. Clair Delta, the only major river delta in the Great Lakes and one of the largest freshwater deltas in the world[24]. The delta's wetlands provide important feeding and resting habitats at a critical location along the Mississippi and Atlantic flyways and are internationally recognized as being of continental significance to hundreds of thousands of migratory waterfowl, shorebirds, and songbirds.[25]

The delta divides flow from the St. Clair River into three main channels and several secondary channels. On the western portion of the delta, the North Channel, South Channel and Middle Channel carry the majority of the flow into the lake. On the eastern portion of the delta, the Chenal Ecarte and Johnson Channel carry much lower volumes of water (See Figure I. C. - 3). The split in flow between the channels is never constant and is strongly affected by discharges from Lake Huron, ice buildup in the channels in winter, plant growth in open-water periods, and winds and other atmospheric factors.

FACT
Lake St. Clair's watershed encompasses approximately 3,927,175 acres (1,589,270 hectares) in Michigan and Ontario, partially or wholly draining 14 counties and numerous municipalities.

Prior to European settlement, a large variety of natural communities occupied the Lake St. Clair shoreline. Beech-maple forests were found on the well drained sites, mixed hardwood swamps were located on the poorly drained sites and unique mosaics of wet and dry communities, referred to as Great Lakes marsh com-

plexes, were located at the mouths of the St. Clair and Clinton Rivers. The marshes at the mouth of the Clinton stretched inland as far as 5 miles along large bends of the river. The largest freshwater delta in the Great Lakes basin formed at the mouth of the St. Clair River. Historically, it supported several unique natural communities: Great Lakes marsh, several lakeplain prairies, a unique grassland community adapted to the fluctuating water levels and poorly drained sands, and lakeplain oak openings, another grassland community with scattered wide-spreading oaks, located on the well-drained beach ridges and dunes. In addition, a large oak-hickory forest was located on a well drained site on the mainland adjacent to this complex.[26]

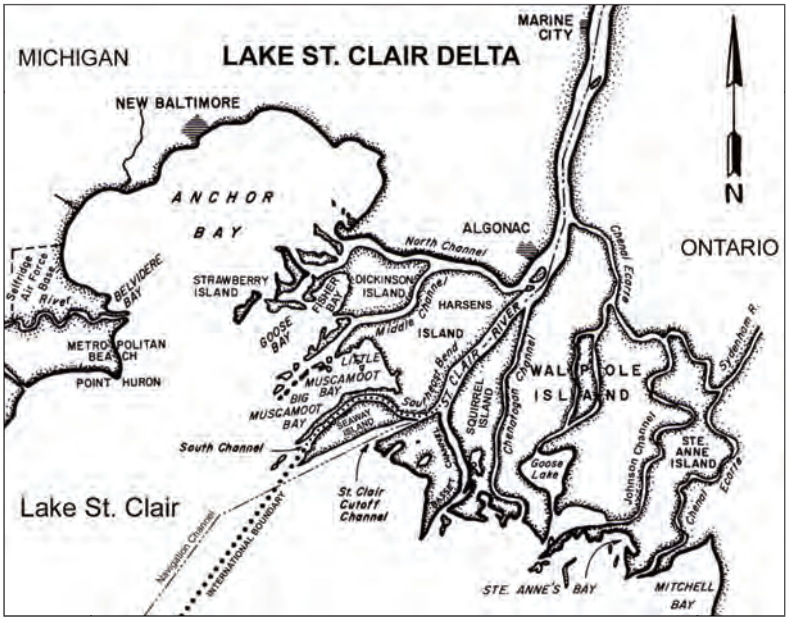


Figure I. C. - 3

Before the logging era, beech-sugar maple forests, located on the well and moderately well drained sites, dominated the landscape. Mixed hardwood swamps, which contained a large variety of trees including American elm, red ash, and silver maple, often occupied large depressions adjacent to the beech-sugar maple forests. Large pockets of lakeplain prairie were found throughout the lakeplain primarily on poorly drained sandy soils particularly along the shoreline between beach ridges. Dry oak-hickory forests, oak savannas, and prairies occupied the well to excessively well-drained beach ridges. Small pockets of black ash swamp, tamarack swamp, bogs, and emergent marsh were found scattered throughout the lakeplain in poorly drained depressions. Kentucky coffee tree, sycamore, red ash, cottonwood, Ohio buckeye, and hackberry were found on the floodplains along the major creeks and rivers[27].

HIGHLIGHT

Most natural communities around Lake St. Clair today have been modified from their European pre-settlement state, are highly fragmented and require intensive management to maintain their "natural" state.

The Lake St. Clair watershed lies within the northern portion of the Eastern Deciduous Forest, also referred to as Carolinian Forest in Canada. Many of the species found here are at the northern extreme of their natural range, so what is considered common elsewhere in the bioregion may be considered rare around Lake St. Clair. Section IV. details the variety of natural communities that exist within the project area today.

The channels in the upstream part of the delta create numerous islands, some of which include residential areas on lands that have been maintained by dikes and seawalls, particularly Harsen's Island and Walpole Island. According to 2000 C-CAP data on both the Canadian and US side, approximately 952 acres (385 hectares), or 1.7 percent of the total area of the 56,000 acre (22,647 hectares) delta consists of either low or high density development. Walpole Island is the largest island in the delta and home to the Walpole Island First Nation people. In addition to Walpole Island itself, the Walpole Island First Nation territory also includes Basset Island, Squirrel Island, St. Anne Island, Potowatami Island, and Seaway Island[28]. Harsen's Island and Dickenson Island, which is relatively undeveloped, are part of the state of Michigan. The southern part of the delta fans out into a complex shoreline of shallow bays and marshes.

Walpole Island First Nation features important remnants of lakeplain prairies, oak savannas and Great Lakes marsh–natural communities that were once widespread through the Lake St. Clair region. These natural features, once common to the entire Lake St. Clair area are now unique remnants that provide some of the most significant wildlife habitat in the Great Lakes.

The St. Clair Flats Wildlife Area, managed by Michigan Department of Natural Resources, refers to that part of the delta encompassing St. John's Marsh, Dickinson Island, Harsen's Island and Algonac State Park and stands as the only major U.S. marsh area remaining on Lake St. Clair. Although their state-owned status offers these lands certain protections from further destruction or alteration, management to maintain and conserve healthy wildlife and plant communities is an ongoing challenge. Implementation of an ecosystem management approach often requires intensive efforts to maintain and conserve healthy wildlife and plant communities. Today's wetland conservation efforts include enhancing waterfowl production and migration habitat and providing waterfowl hunting opportunities. The challenge becomes balancing the goals of enhancing and restoring wetland ecosystems and wildlife populations with those of providing waterfowl hunting opportunities and public access to these wetland resources.

Channel modification, dyking and draining of wetlands, land clearing and development have dramatically altered the landscape and the ecological makeup around Lake St. Clair. These intentional activities have stimulated an entire suite of unintentional and/or secondary activities and impacts such as the introduction of invasive species, higher erosion and sedimentation rates, nutrient and chemical pollution and other factors that further alter the ecological dynamics of the system. As a result, most natural communities around Lake St. Clair today have been modified from their European pre-settlement state, are highly fragmented and require intensive management to maintain their "natural" state.

With an estimated 75–80 percent of Lake St. Clair wetlands destroyed or highly degraded, it becomes increasingly important to provide management strategies that restore, maintain, and/or mimic natural ecosystem processes. On the U.S. side, experts suggest that the St Clair Flats Wildlife Area should be managed at a landscape scale, in a holistic manner that considers both ecological and recreational goals. Restoration and maintenance of existing natural marsh and prairie habitat provides a window to the region's ecological past. This complements manipulation of actively managed habitats by providing a reference point for biological integrity and diversity within the scope of Lake St. Clair. Diked impoundments help provide high quality spring and fall staging habitat for resting and feeding migratory waterfowl. Conservation and restoration of these resources can ensure that the region's biological heritage is not lost and the associated benefits–known and unknown–anthropocentric and ecological–are sustained into the future.

Section 1 Endnotes

1. Although Lake Huron does not have an official Lakewide Management Plan, there is Lake Huron Initiative, which has produced the Lake Huron Initiative Action Plan. The Action Plan is not as extensive as the Lakewide Management Plans being prepared for the other Great Lakes, but is nonetheless a binational effort to address critical issues affecting Lake Huron.

2. Initially, the project study area covered a 1-mile buffer around the lake. Project partners were pleased to learn that data were generated for a 10-mile area, and agreed to increase the project's geographic scope accordingly. The expanded focus increased the study area sixfold: from 49,813 hectares/123,092 acres to 304,548 hectares/752,555 acres or 1,176 sq mi.

3. SEMCOG. Population and Household Estimates for Southeast Michigan, January 2004. Southeast Michigan Council of Governments, January 2004.

4. Although much of this U.S. coastal county population is in Wayne County, most of which is outside the watershed, the people of Wayne County are part of the Lake's coastal population. They have a significant impact on the Lake through vehicular and other air emissions, demands on infrastructure that cross watershed boundaries, and as users of the resource. Wayne county residents enjoy fishing, swimming and boating in Lake St. Clair as much as coastal residents in other coastal counties.

5. Canadian population estimate of 750,000 is the sum of the population of the counties within the Lake St. Clair watershed based on the last national census per the Lake St. Clair Canadian Watershed Technical Report: An examination of Current Conditions. Draft. December 30, 2003. U.S. watershed population figure of 2,207,000 provided by SEMCOG in Comparing 2000 Census and 2030 Regional Development Forecast by Watershed, SEMCOG, 2002.

6. Lake St. Clair Management Plan Final Draft. August, 2003.

7. Mitts, D. M. 1968. That Noble Country: The Romance of the St. Clair River Region. Dorrance and Company, Philadelphia, PA.

8 Jenks, W. L. 1912. History of St. Clair County. Lewis Publishing Co., Chicago, IL. 2 Vols. 904 pp.

9. Mitts, 1968, *op. cit*.

10. Mitts, 1968, *op. cit*.

11. Jenks, 1912, *op. cit*.

12. Herdendorf C. E., Raphael, C. N., Jaworski, E., and Duffy, W. G., 1986. The ecology of Lake St. Clair wetlands: a community profile. Prepared for National Wetlands Research Center, Fish and Wildlife Service, U. S. Department of the Interior, Washington, DC.

13. Edsall, Thomas A., Manny, Bruce A., Raphael, Nicholas, 1988. The St. Clair River and Lake St. Clair, Michigan: an ecological profile. U. S. Fish and Wildlife Service. Biological Report no. 85 (7.3).

14. Edsall, et al, 1988, *op. cit*.

15. USACE (U.S. Army Corps of Engineers). 1981. Essayons. A history of the Detroit District. Detroit District, MI. 215 pp.

16. Edsall, et al, 1988, *op. cit*.

17. Brunk, J. W. 1968. Evaluation of channel changes in St. Clair and Detroit Rivers. Water Resourc. Res. 4:1335-1346.

18. The Formation of Lambton County, at www.lambtoncounty.com/historyformationoflambton.htm

19. Dixon, M.M. 1985. Life at the Flats, Volume I: When Bedore was King. Mervue Publications.

20. Dixon, 1985, *op. cit*.

21. Biodiversity Atlas of the Lake Huron to Lake Erie Corridor. DRAFT. October, 2003. Wildlife Habitat Council.

22. Lake St. Clair Management Plan Final Draft. August, 2003.

23. Lake St. Clair Management Plan Final Draft. August, 2003.

24. Ontario Lake St. Clair MP–Get full reference from E. Kafcas).

25. Michigan Natural Features Inventory, 2003. Summary of the Southeast Michigan Ecosystem Project: 1994-2001. Report No. 2003-07. Michigan State University Extension.

26. The lands that comprise Walpole Island First Nation are under legal dispute between the First Nation and the Government of Canada. For purposes of this document, we will refer to Walpole Island First Nation as the six islands of Walpole, Basset, Squirrel, St. Anne, Potowatami and Seaway Island.

27. MNFI, Ibid

Section II. Socioeconomic Characterization

This section provides information about the communities, institutions and major economic and demographic trends affecting both the project area and the region. Such socio-economic information is critical to proper planning and implementation of conservation and restoration efforts whether at the landscape or site specific scale. Regulatory responsibility is spread among governmental agencies, at multiple levels, and regulations may vary among jurisdictions, so it is important to know where particular responsibilities lie, particularly in regard to laws that govern what happens in the coastal area. Economic information is helpful in assessing where resources are consumed, income and employment are generated and the general level of economic prosperity, which can be an important indicator of public demand and conservation and restoration funding availability. Land use and development trends tell us where development is occurring, at what rate, and suggest factors which may influence those development trends. This is all information that can help in planning a successful conservation and/or restoration project in the coastal Lake St. Clair region.

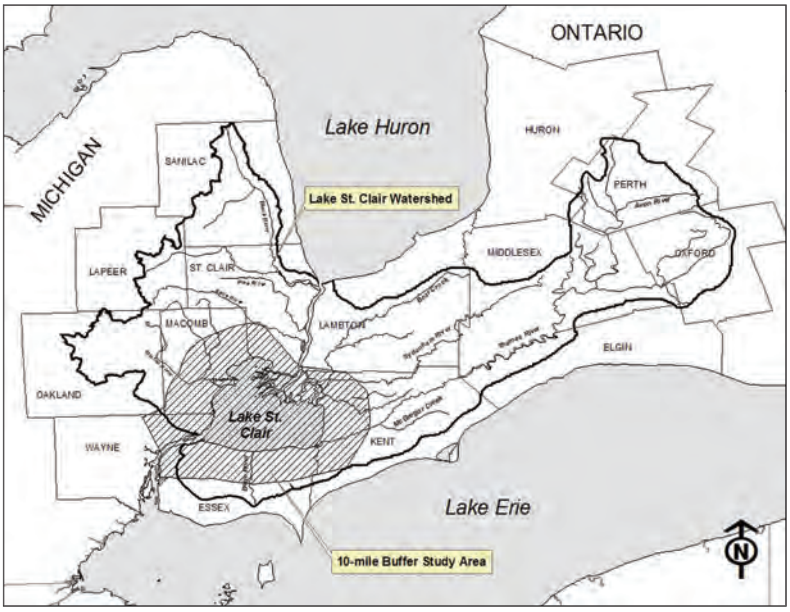


Figure II. A. - 1
Project and watershed overview

II. A. Political Jurisdictions and Institutions

The project area includes the two federal governments of Canada and the United States, Walpole Island First Nation, the Province of Ontario, the State of Michigan and hundreds of cities, towns, villages and unincorporated areas.

FACT

The project area includes the two federal governments of Canada and the United States, Walpole Island First Nation, the Province of Ontario, the State of Michigan and hundreds of cities, towns, villages and unincorporated areas.

Figure II. A. - 1 provides an overview of the watersheds and some of the political jurisdictions within the project area and larger Lake St. Clair watershed.

II. A. 1. United States/Michigan

In the United States, responsibilities for protection of water resources, public health, and the environment are complex and responsibility is often shared among federal, state and local agencies. The following section describes the primary agencies and their roles and responsibilities in public health, environmental protection and natural resource management.

U.S. Federal Government

The U.S. Environmental Protection Agency (EPA) is the primary environmental regulatory body in the United States. Its mission is to protect public health and to safeguard and improve the natural environment. It does this by ensuring that federal environmental laws are implemented and enforced fairly and effectively and that the public has full access to information in order to participate in environmental protection. The National Environmental Policy Act of 1969 (NEPA) is the basic U.S. charter for the protection of the environment. It establishes policy, sets goals and provides the means for carrying out policy. The passage of the Federal Water Pollution Control Act of 1972, began a concerted effort to address sources (mainly point sources) of water pollution, a major stressor of the aquatic environment and associated habitat. The 1977 Federal Clean Water Act Amendments to the Water Pollution Control Act, which followed, began regulating destruction of wetland habitat. Other federal statutes enable the U.S. EPA to regulate specific aspects of the environment including the Clean Water Act (CWA), Comprehensive Environmental Response, Compensation and Liability Act, Resource Conservation and Recovery Act, Clean Air Act and others.

The U.S. Army Corps of Engineers (Corps) provides engineering services including planning, designing, building and operating water resources and other civil works projects. The Corps supports commercial navigation by maintaining and improving navigation channels through dredging, removing impediments and widening and deepening channels. The Corps has authority under both the federal River and Harbors Act of 1899 and the Clean Water Act to determine which areas qualify for protection as wetlands. The Corps also provides a variety of other public services, such as restoration initiatives and flood damage reduction.

FACT

The U.S. Fish and Wildlife Service (FWS) works to conserve, protect and enhance fish, wildlife, plants and their habitats. The Service's major areas of responsibility involve migratory birds, endangered species, certain marine mammals and freshwater and anadromous fish.

The U.S. Department of Agriculture's (USDA) primary role is to oversee the production of agriculture, but it is also a leading conservation agency. Through its Natural Resources Conservation Service (NRCS), the USDA supports voluntary efforts to protect natural resources on private property through programs such as the Wetlands Reserve Program, Watershed Protection and Flood Prevention Operations, Conservation Technical Assistance, and many others.

The U.S. Fish and Wildlife Service (FWS) works to conserve, protect and enhance fish, wildlife, plants and their habitats. The Service's major areas of responsibility involve migratory birds, endangered species, certain marine mammals and freshwater and anadromous fish. Through its Coastal Program, the U.S. FWS focuses its efforts in bays, estuaries and watersheds around the U.S. coastline. Working with other federal and state agencies, local and tribal governments, businesses, conservation organizations and private landowners, the FWS Coastal Program aims to: 1) maintain natural coastal ecosystem diversity, functions and productivity, 2) promote natural, self-sustaining populations of native species within their historic ranges, and 3) provide for ecologically sound levels of public use, economic benefits, and the enjoyment of natural resources.

The U.S. Geological Survey (USGS) serves as an independent fact-finding agency that collects, monitors, analyzes and provides scientific data about natural resources. The USGS has no regulatory or management mandate. Through its National Water Quality Assessment (NAWQA) Program, the USGS is conducting water quality investigations throughout the United States. The Lake Erie-Lake St. Clair basin is one of the NAWQA study areas. An assessment was conducted between 1996 and 1998 and findings were published in 2000 in the report *Water Quality in the Lake Erie-Lake St. Clair Drainage*.[1]

The National Oceanic and Atmospheric Administration (NOAA), housed within the U.S. Department of Commerce, conducts research and gathers data about the global oceans, atmosphere, space and sun, and applies this knowledge to science and service. The National Ocean Service (NOS) is the main part of the NOAA concerned with coastal issues and administers the national Coastal Zone Management Program. NOS collects, monitors, analyzes, and provides scientific understanding about coastal resource conditions, issues, and problems with a focus on four primary goals: promote safe navigation; sustain coastal habitat; support coastal communities; and mitigate coastal hazards. Some of this work is carried out by the NOAA Coastal Services Center.

Table II A 1 - 1 Selected U.S. Federal Agencies and laws that affect coastal land protection and development

Federal Agency	Federal Law
U.S. Environmental Protection Agency and Great Lakes National Program Office	National Environmental Policy Act;Clean Air Act;Clean Water Act; Safe Drinking Water Act;Resource Conservation And Recovery Act; Great Lakes Water Quality Agreement*
U.S. Fish and Wildlife Service	Endangered Species Act; Great Lakes Fish and Wildlife Restoration Act
National Oceanic and Atmospheric Administration (U.S. Department of Commerce)	Coastal Zone Management Act
Natural Resource Conservation Service (U.S. Department of Agriculture)	Great Lakes Basin Program, Farm Security and Rural Investment Act of 2002 (Farm Bill)
U.S. Army Corps of Engineers	Section 404 of the Clean Water Act; dredging and filling of navigable waterways (including wetlands)

*Binational Executive Agreement

State of Michigan

The Michigan Department of Environmental Quality (MDEQ) is the primary state environmental regulatory agency in Michigan. It exercises delegated federal authority and direct state authority, under the Michigan Natural Resources and Environmental Protection Act (NREPA) and a variety of other state environmental and natural resource laws and associated programs. Under NREPA, Michigan's natural resources lakes and streams, floodplains, adjacent uplands, as well as farmland and open space are regulated and protected.

FACT
The Michigan Department of Environmental Quality (MDEQ) is the primary state environmental regulatory agency in Michigan.

Through its water programs, MDEQ establishes water quality standards, assesses water quality, provides regulatory oversight for all public water supplies, issues permits to regulate the discharge of industrial and municipal waste waters, and monitors state water resources for water quality, the quantity and quality of aquatic habitat, the health of aquatic communities, and compliance with state and federally delegated laws. The MDEQ shares responsibility for wetlands protection with the U.S. Army Corps of Engineers. MDEQ also administers the state Coastal Management Program (See case study on page 34).

The Michigan Department of Natural Resources (MDNR) is committed to the conservation, protection, management, use and enjoyment of the State's natural resources for current and future generations. The MDNR is responsible for management and regulation of Michigan's public trust resources, including fish and wildlife.

The Michigan Department of Community Health (MDCH) is responsible for health policy and management of the state's publicly funded health service systems. MDCH provides an annual Michigan Fish Advisory online, which described which fish pose a risk to human health based upon consumption frequency, location of catch and fish species at *www.michigan.gov/documents/FishAdvisory03_67354_7.pdf*. MDCH works in conjunction with MDEQ to oversee beach water quality monitoring and develop standards for waters used for swimming.

U.S. Local Government

Decisions made at the local level critically impact the quality of the St. Clair River and Lake St. Clair. On the U.S. side, all or parts of 153 county, township and municipal governments are located within the Lake St. Clair watershed. These local governments are responsible for almost all land use decisions within their jurisdictions, including the location of residential, commercial, and industrial development, road improvements and the planning and construction of water and sewer lines.

HIGHLIGHT

Local municipalities have direct responsibility to implement water quality requirements in the areas of stormwater management, soil erosion control, flood control and in operating municipal drinking water and wastewater treatment systems.

In addition, numerous special purpose jurisdictions, such as local school districts, water and sewer authorities, and waste disposal authorities, also possess autonomous authority to make land use decisions. Zoning and planning laws and laws that grant powers to special purpose jurisdictions generally do not impose specific environmental requirements on these local entities, although federal and/or state environmental permitting requirements apply to particular projects.

Local municipalities have direct responsibility to implement water quality requirements in the areas of stormwater management, soil erosion control, flood control and in operating municipal drinking water and wastewater treatment systems.

Local governments may also engage in voluntary collaborative efforts. For example, the Macomb-St. Clair Inter-County Watershed Management Advisory Group has sponsored the Anchor Bay Watershed Management Initiative, a cooperative effort to develop a watershed management plan for the Anchor Bay sub-watershed.

HIGHLIGHT

In Canada, a combination of federal and provincial laws and policies together with controls exercised by local authorities provide protection of water resources, public health and the environment. The division of responsibilities for water and other environmental issues is complex and responsibility is often shared.

II. A. 2. Canada/Ontario

In Canada, a combination of federal and provincial laws and policies together with controls exercised by local authorities provide protection of water resources, public health and the environment. The division of responsibilities for water and other environmental issues is complex and responsibility is often shared[2].

By virtue of the Constitution Act, provinces own water resources and have the authority to legislate areas of water supply and pollution control. Water on federal lands and on the reserves of Canada's aboriginal peoples falls under federal jurisdiction. The National Parliament has specific responsibility for fisheries as well as navigation, international undertakings and native affairs. Thus, there are interactions among several different areas of Canadian jurisdiction when dealing with international boundary waters such as Lake St. Clair[3]. Similar to the U.S., the administration of air and waste regulations involves both federal and provincial responsibilities.

Canadian Federal Government

Canada is a signatory to several treaties and agreements with the United States dealing with waters that flow along or across the common boundary. The federal government has a fiduciary responsibility to the First Nations within the Lake St. Clair watershed[4]. These include Walpole Island First Nation (Bkwejwanong), Chippewas of Aamjiwnaang (Sarnia), Delaware Nation (Moravian of the Thames), Caldwell First Nation, Chippewas of the Thames, Oneida of the Thames, and Munsee Delaware Nation.

Environment Canada (EC) has a mandate under the Department of the Environment Act to preserve and enhance the natural environment, carry out objectives of the Great Lakes Water Quality Agreement (GLWQA), and coordinate federal environmental policies. The Canada Water Act provides for management of the water resources of Canada in cooperation with the provincial governments[5].

Under the Canadian Environmental Protection Act (CEPA), Environment Canada and Health Canada share the task of managing risks associated with toxic substances and filling gaps for environmental protection when there is no coverage under other federal acts.

HIGHLIGHT

The Species at Risk Act (SARA) received Royal Assent in December 2002 and came into force in 2003. Under SARA, there is increased protection for endangered species and other species at risk.

The Canadian Wildlife Service (CWS) is a branch of Environment Canada that handles federal wildlife issues, such as those arising from the Migratory Bird Convention Act that implements the 1916 treaty between Canada and the United States. The Canada Wildlife Act gives the federal government the authority to acquire habitat for migratory birds. Within the project area, the CWS owns and manages the St. Clair Wildlife Refuge. The Species at Risk Act (SARA) received Royal Assent in December 2002 and came into force in 2003. Under SARA, there is increased protection for endangered species and other species at risk. Environment Canada and the Department of Fisheries and Oceans Canada (DFO) share responsibility for implementing SARA, with DFO being responsible for aquatic species and habitat[6].

Fisheries and Oceans Canada has legislative responsibility for administration and enforcement of the Fisheries Act. A Memorandum of Understanding between DFO and EC outlines the responsibilities of both departments. DFO manages the protection of fish habitat under Section 35 of the Fisheries Act that controls work done in or near water that could result in the alteration, disruption or destruction of fish habitat. Projects can range in size and complexity from the installation of a culvert for a road crossing to the development of a large mine. The DFO has developed working arrangements with many Ontario Conservation Authorities to undertake review of project proposals. Depending on the significance of the project, an environmental assessment under the Canadian Environmental Assessment Act (CEAA) may be required. The Canadian Environmental Assessment Agency, which administers the CEAA, and DFO conduct and coordinate the assessment review concurrent with the review process for authorization under the Fisheries Act[7].

Agriculture is a shared responsibility of the federal and provincial governments. In June 2002, Agriculture and Agri-Food Canada, in cooperation with the provinces, announced a framework for agriculture in Canada. One goal of the Agricultural Policy Framework (APF) is to minimize agricultural impacts on water, with special attention paid to the effects of nutrients, pathogens, and pesticides on aquatic ecosystems. These goals will be accomplished through federal-provincial negotiations that will set environmental targets and through federal-provincial programs that will address on-farm land use, nutrients, pesticides, and other substances[8].

Province of Ontario

The government of Ontario shares responsibility with the government of Canada to protect the environment and public health. In 1971, both governments signed the first Canada-Ontario Agreement Respecting the Great Lakes Basin

FACT

As part of the Ontario government's Clean Water Strategy, the Nutrient Management Act provides for province-wide standards to address the effects of agricultural practices on the environment such as the application of manure to land.

Ecosystem. The Ontario Ministry of the Environment (OMOE) and EC are the lead agencies for the agreement. In 2002, Canada and Ontario signed an updated agreement with several annexes that address specific environmental issues in detail and set specific commitments by each government. The current annexes include Areas of Concern, Harmful Pollutants, Lakewide Management Plans and Monitoring and Information Management. New annexes can be added at any time to address emerging issues[9].

The OMOE has primary responsibility for pollution control for the provincial government. The major pieces of provincial legislation are the Ontario Water Resources Act, the Environmental Protection Act, the Environmental Assessment Act, the Environmental Bill of Rights, and the Pesticides Act. These acts provide general prohibitions or control over activities such as use of water resources, waste management, discharges to land, water and air or the use of pesticides[10].

The Ontario Ministry of Agriculture and Food is involved with research and extension activities to support Ontario's agri-food industry. Ontario enacted the Nutrient Management Act in July 2002 that will protect water from agricultural nutrients. This act aims to set clear, consistent standards for nutrient management on farms and protect the environment. As part of the Ontario government's Clean Water Strategy, the Nutrient Management Act provides for province-wide standards to address the effects of agricultural practices on the environment such as the application of manure to land[11].

A number of acts and regulations govern the activities of resource users and are administered by the Ontario Ministry of Natural Resources (e.g., Lakes and Rivers Improvement Act, Public Lands Act). The Ontario Endangered Species Act provides for the protection of endangered species and their habitat. This act, together with the Federal Species at Risk Act, forms the network in Ontario for protecting species at risk[12].

HIGHLIGHT

The Ontario Endangered Species Act provides for the protection of endangered species and their habitat. This act, together with the Federal Species at Risk Act, forms the network in Ontario for protecting species at risk.

The Ministry of Municipal Affairs and Housing (MMAH) manages four major areas: local government, land use planning, housing market and building regulation. Many of the actions and efforts of this ministry have direct or indirect impacts on the environment. For example, the 2001 Brownfields Statute Law Amendment Act gives MMAH authority to help remove obstacles to cleaning up former industrial sites. The Ministry also oversees implementation of the Planning Act, which delegated land use planning authority to municipal governments. The Provincial Policy Statement of the Planning Act provides policy direction to municipalities on matters of provincial interest regarding land use planning. This includes land use in and adjacent to natural features such as wetlands (See Section II. D. 1. for a description of Canadian planning policies).

Canadian Local Government

In Canada, municipalities are created only by the province. The Municipal Act sets the terms by which the provinces establish such local governments. In the more heavily populated southern part of the province, two-tiered regional governments were established in the 1970s to assist municipalities with planning for development, with the "upper

tier" being the county or region and the "lower tier" being the city, township or village. Under the two-tier system of local governance, functions are divided between the two levels. Exact responsibilities vary from place to place, but generally the upper tier--regional government--takes on functions such as regional planning, sewer and water infrastructure planning, major roads, transit, policing and some social services. The local governments deal with local planning, parks, garbage collection, etc. There is often duplication between the two levels--with respect to economic development initiatives, for instance. Where there is only one level of municipal government in an area it is called a "single tier" municipality[13].

FACT

In Ontario, parts of nine counties and over thirty local municipal governments are located in the Lake St. Clair watershed. There are also seven First Nation reserves located in the watershed.

In Ontario, parts of nine counties and over thirty local municipal governments are located in the Lake St. Clair watershed. There are also seven First Nation reserves located in the watershed. Seven Ontario municipalities share the Lake St. Clair and St. Clair River shoreline. In Lambton County, the Village of Point Edward, the City of Sarnia, and the Township of St. Clair (formerly Sombra and Moore Townships) stretch along the St. Clair River from Lake Huron to the beginning of the Chenal Ecarte. Walpole Island First Nation is located on the St. Clair Delta. The Corporation of the Municipality of Chatham-Kent, which was formed by combining 23 local municipalities, reaches from the beginning of the Chenal Ecarte to the mouth of the Thames River at the southeastern corner of Lake St. Clair. The County of Essex has undergone a major restructuring which reduced the County from twenty-one local municipalities to seven. The new seven municipalities in Essex County are as follows: Amherstburg, Essex, Kingsville, Lakeshore, LaSalle, Leamington and Tecumseh.[14]

Conservation Authorities

The Province of Ontario enacted the Conservation Authorities Act in 1946. This allowed municipalities to establish local Conservation Authorities that could provide comprehensive watershed planning and management activities. The Conservation Authorities Act was based on the premises that the logical way to coordinate conservation work was on a watershed basis and that the initiative must come from the local people. Created through a partnership of municipalities – at least two-thirds of the municipalities in a watershed had to agree to form an authority – and governed by a municipally-appointed Board of Directors, these authorities can address conservation issues across municipal boundaries[15].

HIGHLIGHT

Four watershed-based Conservation Authorities have jurisdiction within the Lake St. Clair watershed.

Four watershed-based Conservation Authorities have jurisdiction within the Lake St. Clair watershed. The St. Clair Region Conservation Authority has jurisdiction over all watersheds of streams that drain into the St. Clair River, the Sydenham River and Lake St. Clair north of the mouth of the Thames River. The Thames River is divided into two jurisdictions: Lower and Upper. The Lower Thames Valley Conservation Authority has responsibility for watersheds of all streams that drain into the Thames River from the Village of Delaware to Lake St. Clair. The Upper Thames River Conservation Authority has responsibility for all the watersheds of streams that drain into the Thames River above the Village of Delaware. The Essex Region Conservation Authority has jurisdiction over the watersheds of streams in Essex County draining directly into Lake St. Clair[16].

II. A. 3. Walpole Island First Nation

Walpole Island is part of the traditional homeland of the Potawatomi, Ottawa and Ojibwa people, who together comprise a political compact known as the Three Fires Confederacy. Walpole Island has been administered as "Reserve"

FACT

The Walpole Island First Nation continues to assert and exercise Aboriginal title to its territory, unceded lands and waters. Walpole Island was the first "Reserve" in Canada to function outside of the Indian Agent system when Chief and Council removed the agent in 1965.

land for over 150 years. The Ottawa and Ojibwa were original occupants of what is now known as southwestern Ontario, while the Potawatomi settled permanently on Walpole Island after 1836.

Walpole Island was not included in any of the 18th and 19th century land surrenders and treaties and the Walpole Island Reserve boundary has never been clearly established. The Walpole Island First Nation continues to assert and exercise Aboriginal title to its territory, unceded lands and waters. Walpole Island was the first "Reserve" in Canada to function outside of the Indian Agent system when Chief and Council removed the agent in 1965. This event significantly advanced the First Nation self-government movement. Walpole Island is a part of the federal Electoral Riding of Kent Lambton Middlesex and Ontario Electoral Riding of Lambton[17].

Walpole Island First Nation is in large part comprised of six islands in the St. Clair River Delta on the south and east side of the international border delineated by the St. Clair River and South Channel of the St. Clair River, including: Walpole, Squirrel, St. Anne, Seaway, Bassett, and Potawatomi, which collectively have 87 miles of shoreline[18]. In total and "Without Prejudice to Pending & Future Land Claims" Walpole Island First Nation is approximately 58,000 acres (23,472 hectares) in size. Of this, approximately 43 percent is classified as prime agricultural land (Class 1,2 and 3 Soils by Canada Land Inventory) and 30 percent is wetlands.

FACT

Nearly all of the households on Walpole Island are directly or indirectly involved with hunting, fishing and trapping activities. Recreational tourism is the number one industry.

Nearly all of the households on Walpole Island are directly or indirectly involved with hunting, fishing and trapping activities. Recreational tourism is the number one industry. The second largest industry is agriculture. In 1971, Tahgahoning Enterprise was established with 200 acres. Today, Tahgahoning Inc. operates a 4,400 acre cash crop farm and dryer/storage facility. The third ranking and fastest growing sector is government services. The remainder of the population is involved in manufacturing, trade industries, transportation, communications and other utility industries and miscellaneous commercial activities. Local facilities include an economic development and industrial-training complex and the Thunderbird Mall.

II. B. Population Growth/Migration

The following discussion of population growth and migration is separated between the U.S. and Canada, due primarily to different data sources and collection time frames in each country, which made combining the population trends unfeasible.

U.S. Regional Summary 1990 to 2000

Between 1990 and 2000, the seven county region of Southeast Michigan grew by more than 230,000 to 4.83 million total population, an increase of 5.1 percent[19]. This includes the cities, villages, townships, and counties, within the seven county area of Livingston, Macomb, Monroe, Oakland, St. Clair, Washtenaw, and Wayne Counties. During this time, the region's households (number of houses) grew at a faster rate than population. In 1990, there were 1.69 million households which grew to 1.87 million households in 2000–a 10.4 percent increase. Households growing faster than

FACT

Between 1990 and 2000, housing increases outpaced the population growth by a factor of two to one. Households have fewer members, but more houses occupy more land - human impacts on the destruction and fragmentation of habitat are accelerating.

population can be explained by the changing composition of households over time. While households with children have remained relatively stable over time, there has been a significant increase in the number of households without children, as the children of baby boomers have grown up and moved from home leaving their parents as empty nesters. The overall result has been a steady decline in the average household size, from 2.66 in 1990 to 2.53 in 2000[6].

Between 1990 and 2000 the three coastal counties in the study area that border Lake St. Clair (St. Clair, Macomb, Wayne) experienced an average 13.1 percent increase in number of households compared with a 6.1 percent increase in population. Consistent with regional and statewide trends, the increase in households far outpaced population increase.

Averaging out changes in the three coastal counties can sometimes obscure unique changes or circumstances. Only a small portion of the study area lies within Wayne county, which is the home of Detroit. Demographic changes in Wayne county were very different from those in Macomb and St. Clair. Table II B - 1 shows population and household changes for the three counties between 1990 and 2000[20].

Table II B - 1 Population and Household Changes 1990-2000

County	Total Population				Households			
			Change: 1990-2000				Change: 1990-2000	
	1990	2000	Number	%	1990	2000	Number	%
Macomb	717,400	788,149	70,749	9.9	264,991	309,203	44,212	16.7
St. Clair	145,607	164,234	18,627	12.8	52,882	62,072	9,190	17.4
Wayne	2,111,687	2,035,536	-76,151	-3.6	780,535	788,873	8,338	1.1
Southeast Michigan	**4,590,468**	**4,833,492**	**243,024**	**5.3**	**1,698,819**	**1,845,313**	**146,494**	**8.6**

Wayne county experienced only a slight increase in households between 1990 and 2000 (1.1 percent) while losing more than 76,000 residents–a 3.6 percent population decrease. In contrast, St. Clair and Macomb counties added 58,208 households (a 19.1 percent increase) and experienced an 11 percent increase in population during the decade.

St. Clair and Macomb counties alone absorbed 36 percent of both total population increase and total increase in households in southeast Michigan from 1990 to 2000. In the year 2000 these two counties had 19 percent of the total population and 20 percent of the total households in southeast Michigan, compared to 18 percent of the population in 1990 and 18 percent of households in 1990. By the year 2000, 30 percent of the state's population (3,013,546) were living in one of the three counties bordering Lake St. Clair.

Within the three coastal counties along Lake St. Clair, population trends in communities within the 10 mile project area compared to the rest of the county, are about the same. Any community with at least 50 percent of its total area within the ten mile project area study area along the coast, was included as defined as being within the project area. In the period 1990 to 2000 population and numbers of households both increased in Macomb and St. Clair counties as

a whole, but those areas within the project area were about the same or even slightly less than the rest of the county. (See Table II B- 2.)

Table II B - 2 1990-2000 Population and Household Estimates for Coastal Communities within Project Zone

	Total Population		Pop Change '90-'00		Total Households		HH Change '90-'00	
	April 1990	April 2000	number	percent	April 1990	April 2000	number	percent
Macomb Co. Project Area	636,545	681,626	45,081	7.1	237,289	269,877	32,588	13.7
St. Clair Co. Project Area	26,853	29,962	3,109	11.6	9,798	11,500	1,702	17.4
Wayne Co. Project Area	1,150,616	1,071,909	-78,707	-6.8	422,498	382,793	-39,705	-9.4
Macomb Co. Project as %Total	88.7%	86.5%			89.5%	87.3%		
St. Clair Co. Project as %Total	18.4%	18.2%			18.5%	18.5%		
Wayne Co. Project as %Total	54.5%	52.0%			54.1%	49.8%		

For example, in 1990, 88.7 percent of the total population in Macomb county lived within the project area. The population of the project area had increased by the year 2000, but in that year it represented 86.5 per cent of the total county population. St. Clair county was about the same[21].

U.S. Regional Summary 2000 to 2004

As shown in Table II B - 3 all counties in Southeast Michigan, except for Wayne County, experienced population and household growth since the last (2000) census[22]. Similar to the past decade, population and numbers of households both increased in Macomb and St. Clair counties from 2000 to 2004. In the context of the southeast Michigan region, 61 percent of the population increase and 44 percent of the increase in households during this time occurred in Macomb and St. Clair counties alone[23]. Of the two, Macomb experienced the greatest gain with 33,000 more persons and 16,000 more households.

FACT
All counties in Southeast Michigan, except for Wayne County, experienced population and household growth since the last (2000) census.

As a percentage of the total, population and household growth within the ten-mile coastal project area of Macomb and St. Clair counties were about the same or less than in their respective counties overall (See Table II B - 3). Over 86 per cent of the total population in Macomb County is within the 10 mile shoreline project area of Lake St. Clair.

Table II B - 3 2000-2004 Population and Household Est. Communities within Buffer Zone

	Total Population		Pop Change 00 - 5/04		Total Households		HH Change 00 - 5/04	
	April 2000	Est. May 2004	number	percent	April 2000	Est. May 2004	number	percent
Southeast Michigan	4,833,368	4,896,751	63,383	1.3	1,845,218	1,898,890	53672	2.9
Macomb County	788,149	821,031	32,882	4.2	309,203	329,409	20206	6.5
St. Clair County	164,235	170,362	6,127	3.7	62,072	65,534	3462	5.6
Wayne County	2,061,162	2,021,198	-39,964	-1.9	768,440	760,744	-7696	-1.0

Macomb Co. Buffer Area	681,626	706,956	25,330	4.0	269,876	286,216	16340	6.0
St. Clair Co. Buffer Area	29,963	30,089	126	0.0	11,501	11,755	254	2.0
Wayne Co. Buffer Area	1,071,989	1,026,480	-45,509	-4.0	382,833	365,871	-16962	-4.0
Macomb Co. Buffer as %Total	86.5%	86.1%			87.3%	86.9%		
St. Clair Co. Buffer as %Total	18.2%	17.7%			18.5%	17.9%		
Wayne Co. Buffer as %Total	52.0%	50.8%			49.8%	48.1%		

Many communities are growing faster than the regional household and population average of one percent and 0.7 percent, respectively. Macomb Township and New Baltimore are noteworthy in that household and population increases have been faster than average since the last census.

FACT

In absolute terms, Macomb Township exceeds all other Southeast Michigan communities in both population and household gain.

In absolute terms, Macomb Township exceeds all other Southeast Michigan communities in both population and household gain. With an increase of 14,000 persons and 5,000 households since the 2000 Census, Macomb Township accounts for 16 percent of population growth in Southeast Michigan and 10 percent of the region's additional households and now ranks as the 19th most populous community in the region. Other communities with population growth averaging more than 1,000 persons per year since 2000 within the three coastal counties along Lake St. Clair include Chesterfield and Shelby Township. In percentage terms, the communities of New Baltimore and New Haven have increased their population by more than 30 percent since 2000.

In sum, the coastal project area in both Macomb County and St. Clair County are growing at about the same rate as the counties, respectively, and even the larger region. This growth, particularly with increasing households, represents continued demands to convert what remaining habitat does exist to accommodate new households and associated commercial and other development, both within and beyond the coastal project area. Similarly, population growth further away from the shore does not mean that pressure on the Lake will be reduced. Indeed, the additional people can be expected to travel further to enjoy the Lake's many amenities. Anywhere within a couple hours of driving is considered reasonable to spend a day at or on the lake. Amidst these trends, conservation and restoration of coastal habitat is imperative to maintain ecological functions and ensure the quality of life that is derived from living in or near a coastal area. More discussion about the role of population growth on land use trends and impacts is included in Section II. D. 2.

HIGHLIGHT

Conservation and restoration of coastal habitat is imperative to maintain ecological functions and ensure the quality of life that is derived from living in or near a coastal area.

U.S. Future Projections to 2030

The seven county area of Southeast Michigan is projected to experience a 12 percent population increase between 2000 and 2030, reaching a total of 5.4 million people. The region's growth rate has been similar to the overall growth rate for the state of Michigan, which is about half the rate of the entire United States. "Domestic migration," or population movement within the United States, has resulted in a net loss of total population for the southeast Michigan area. It is

caused primarily by young people seeking opportunities for better quality of life elsewhere outside of the seven county area of SEMCOG[24].

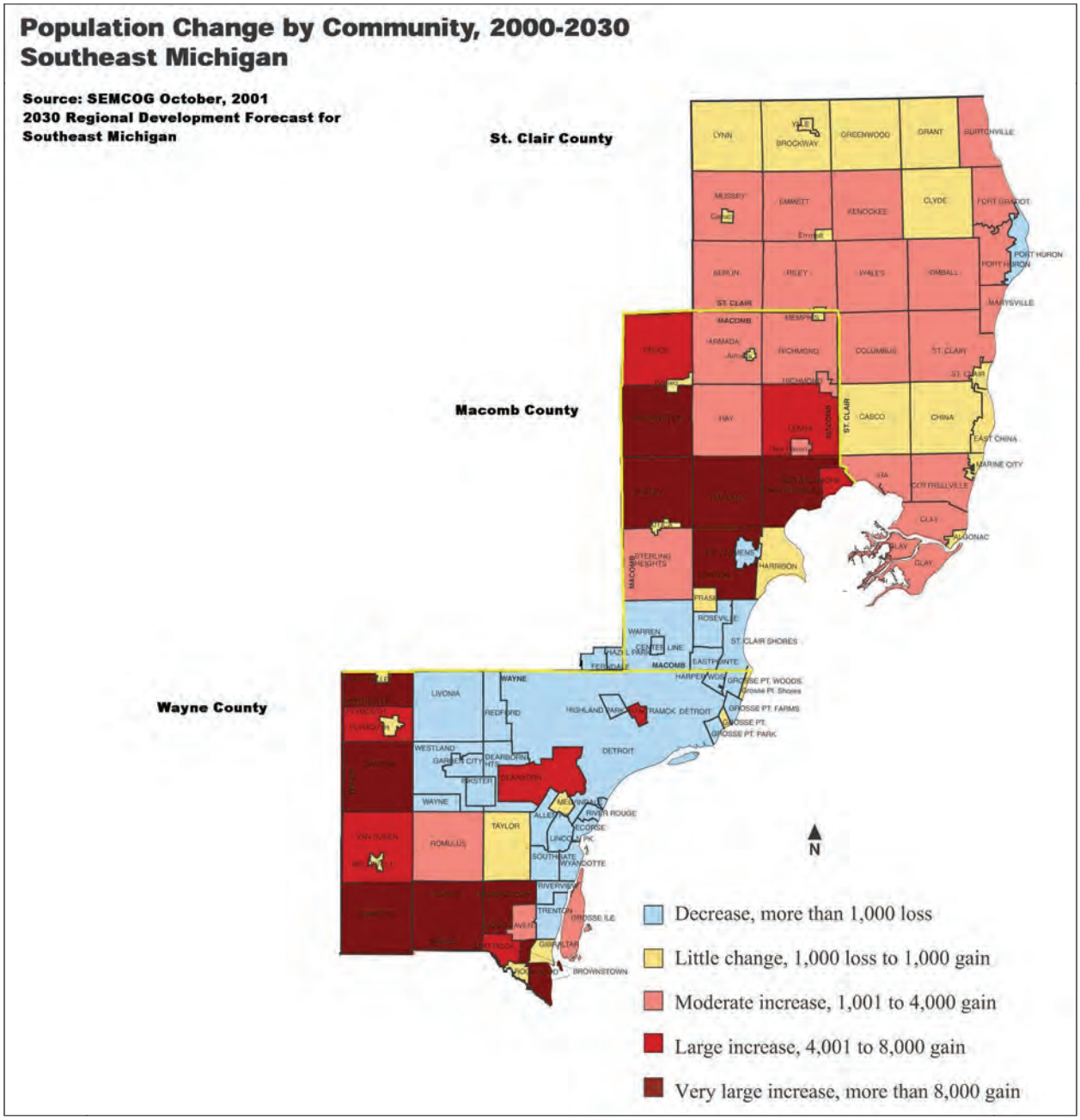


Figure II B - 1

Figure II B - 1 shows population change by community between 2000 and 2030 in the three U.S. counties bordering Lake St. Clair. The pattern of population change is generally one of growth outside Detroit and its mature suburbs. Southern and western Wayne County and central Macomb County are among the areas projected to be the fastest growing. The City of Detroit's historically high rates of population and household loss have slowed considerably and this decline is expected to continue.

Table II B - 4 summarizes the expected population growth per county in the seven county region of SEMCOG from 1990 to 2030. From 1990 to 2030, the population of Macomb and St. Clair Counties is expected to increase by a total of 266,892. This is 33 percent of the total estimated regional population growth of 810,820.

Table II B - 4 2030 Regional Development Forecast for Southeast Michigan

County	1990	2000	2005	2010	2015	2020	2025	2030	Pop Change	
									number	percent
Livingston	115,645	156,951	179,733	196,950	216,914	239,059	260,038	282,405	166,760	144.20%
Macomb	717,400	788,149	811,251	830,143	851,415	876,371	903,489	926,347	208,947	29.10%
Monroe	133,600	145,945	156,533	167,375	175,108	182,345	186,695	191,500	57,900	43.30%
Oakland	1,083,592	1,194,156	1,229,625	1,258,206	1,288,922	1,309,461	1,330,428	1,346,185	262,593	24.20%
St. Clair	145,607	164,235	171,312	176,795	185,608	192,626	198,375	203,552	57,945	39.80%
Washtenaw	282,934	322,895	342,163	365,603	384,075	401,076	418,269	433,205	150,271	53.10%
Wayne	2,111,687	2,061,162	2,046,588	2,038,012	2,027,915	2,015,793	2,012,421	2,018,091	-93,596	-4.40%
Detroit	1,027,979	951,270	928,582	908,883	892,263	878,817	869,462	865,167	-162,812	-15.80%
Balance Wayne	1,083,708	1,109,892	1,118,006	1,129,129	1,135,652	1,136,976	1,142,959	1,152,924	69,216	6.40%
Region	4,590,465	4,833,493	4,937,205	5,033,085	5,129,958	5,216,731	5,309,715	5,401,285	810,820	17.70%

Table II B - 4 summarizes the expected population growth per county in the seven county region of SEMCOG from 1990 to 2030. From 1990 to 2030, the population of Macomb and St. Clair Counties is expected to increase by a total of 266,892. This is 33 percent of the total estimated regional population growth of 810,820.

The Integrated Coastal Management Tool (described in Section VII) developed as part of the Lake St. Clair Coastal Habitat Project has been designed to use the SEMCOG-generated population data when performing analyses to identify and rank potential conservation areas or assist with other land use planning decisions.

Canadian Regional Summary 1996-2001

On the Canadian side of Lake St. Clair, the three counties of Essex, Chatham-Kent and Lambton border Lake St. Clair. Of these three, Essex has the largest population and includes the city of Windsor and the Windsor Census Metropolitan Area (CMA) which includes Tecumseh, La Salle and parts of Lakeshore, Essex and Amherstburg. Essex county borders the southern shore of Lake St. Clair, while Kent County borders the eastern shore and Lambton county is only adjacent for a short distance on the northeast shoreline of the lake. In 2001 the population of Chatham-Kent was 112,800 persons. Since the recession of the early 1990's the municipality of Chatham-Kent has experienced no growth and more recently (between 1996 and 2001) negative growth. A population decline in the past five years has taken place in agricultural/rural areas while overall the population in the urban centers has remained stable. The largest municipality in the county is Chatham with a 2001 population of 43,409. There are only 6 other municipalities (urban centers) in the county with a population over 1000. In 2001 the share of Chatham-Kent's population in the urban centers was 66 percent - up from 64 percent in 1986. Chatham, Blenheim and Tilbury have experienced positive growth while Dresden has been stable and Wallaceburg and Ridgetown have experienced population declines.[25]

FACT

Three Canadian counties border Lake St. Clair: Essex County borders the southern shore, Kent County lies along the eastern shore and Lambton County is adjacent for only a short distance on the northeast shore of the lake.

Table II B - 5 summarizes the population growth for the area from the Canadian census from 1996 to 2001. The Canadian national census is conducted every five years. Essex County has about three times the population of the other two individual counties, with a population growth of seven percent while the other two declined in population. The

City of Windsor and the Windsor CMA are in the northern section of Essex County and fall within the ten mile coastal project area of Lake St. Clair.

Table II B - 5 Pop Growth in Canadian Counties on Lake St. Clair: 1996 to 2001

Community	Pop 1996	Pop 2001	% change '96 - '01	Pop Density per sq kilometre
Essex County Ont.	350,329	374,975	7	202.5
Lambton County Ont.	128,975	126,971	-1.6	42.3
Chantam-Kent Co Ont	109,350	107,341	-1.8	43.7
Windsor CMA Ont.	286,811	307,877	7.3	301.1
Windsor City, Ont.	197,694	208,402	5.4	1,727.7
Population Totals	1,073,159	1,125,566		

Geographically Essex County is a peninsula extending off the southern tip of Ontario, between Lake St. Clair on its north, Lake Erie on its south, and the Detroit River to its west. About 60 per cent of the Canadian side of the lake is along Essex County. At its widest point from north to south, the county is only about 30 miles wide. Thus, any population growth within this county will be a maximum of 30 miles from Lake St. Clair Shore. Importantly, this area shows the highest population increase in southwest Ontario, along with the highest population density. The Windsor CMA is now the 15th largest in Canada and grew 7.3 per cent in total population, compared to a rate of 6.1 per cent for all of Ontario[26].

HIGHLIGHT

The population of Southwestern Ontario will increase through the year 2028, but its percent of the total population in Ontario is expected to fall from 13.1 percent in 1999 to about 11.4 percent in 2028, due to faster growth rates in other parts of the province (especially in the Greater Toronto Area).

Canadian Regional Future Projections to 2028

The population of Southwestern Ontario will increase through the year 2028, but its percent of the total population in Ontario is expected to fall from 13.1 percent in 1999 to about 11.4 percent in 2028, due to faster growth rates in other parts of the province (especially in the Greater Toronto Area). Growth rates for the Southwestern Ontario region will vary, with the Census Divisions of Elgin and Essex projected to have growth rates close to the provincial average[27].

The City of Windsor Planning Department estimates that future population growth within the city itself will increase 20 percent through 2026 (See Table II B - 6). Windsor's share of the census metropolitan area's population has gradually declined since 1966 as the other metropolitan municipalities have developed.

Table II B - 6, City of Windsor, population growth estimates to 2026

2001	2006	2011	2016	2021	2026	Population Change '01-'26	
						number	percent
208,425	218,467	228,263	236,948	244,811	251,917	43,492	20

Over the next twenty years, however, Windsor's share is anticipated to stabilize as the surrounding CMA's accommodate peripheral growth, particularly in the towns of LaSalle, Tecumseh and Lakeshore.

Future population projections shown in Table II B - 7 indicate that Kent and Lambton will have modest population increases totaling two per cent for each county, while Essex will have a 19 percent total increase in the projected period. The estimated population growth through 2028 for Essex alone will be 76,900–15 times that of the other two counties combined. In the northern half of the Essex county on the Lake St. Clair shoreline, the municipalities of LaSalle, Tecumseh and Lakeshore are expected to increase population from 30 to 45 percent from 1996 to 2016[28]. This concentrated population growth in close proximity to Lake St. Clair will more than likely place greater demands on the lake's resources, including habitat along and near the shore.

Table II B - 7 Population Projections for Canadian Lake St. Clair Coastal Counties Through 2028

County	2006	2011	2016	2021	2026	2028	Change 2006-2028	
							number	percent
Essex	402,800	421,500	439,700	457,300	473,700	479,700	76,900	19%
Kent	113,800	114,800	115,700	116,300	116,600	116,600	2,800	2%
Lambton	131,200	132,300	133,400	134,000	133,800	133,500	2,300	2%
Ontario (Total)	**12,526,200**	13,198,900	13,860,100	14,508,500	15,124,400	15,354,900	2,828,700	23%

Source: Ontario Ministry of Finance, July 2000

II. C. Economic Profile

Manufacturing and the support services to manufacturing and resident populations play a large part in the economies of both Southeast Michigan and Southwest Ontario.

The commercial navigation channel through Lake St. Clair carries approximately 5,000 – 6,000 commercial vessel transits each year. The Detroit/Wayne County Port Authority estimates that ports under their jurisdiction generated $17 million (USD) in the year 2000. These activities directly employed 5,851 persons and indirectly an additional 4,405 persons. The income generated from these activities was $551 million (USD) with business revenues in excess of $165 million (USD). Sarnia Vessel Traffic Services (VTS) provides marine communications and traffic services for Southern Lake Huron, St. Clair and Detroit River waterway and Western and Central Lake Erie through the Canadian Coast Guard, which reports over 3,000 vessels arriving at the Port of Detroit, 1,719 at Windsor and 428 at Amherstburg during the 2003 commercial season[29].

FACT

Lake St. Clair provides a vital link for commercial vessels that make up to 5,000 transits across the lake each year. Despite its significance as a maritime transportation corridor, the lake's naturally shallow depths have limited the development of deep-water commercial harbors.

Lake St. Clair provides a vital link for commercial vessels that make up to 5,000 transits across the lake each year. Despite its significance as a maritime transportation corridor, the lake's naturally shallow depths have limited the development of deep-water commercial harbors. The only ports are north along the St. Clair River at Sarnia and south along the Detroit River in Detroit, Windsor and Amherstburg. On the other hand, naturally shallow waters have provided a Mecca for small boats and the development of associated recreational facilities.

The recreational benefits of Lake St. Clair are estimated at $200 million (USD) on the Michigan side alone. The U.S. EPA Region 5 Southeast Michigan Inland Sensitivity Atlas records 131 marinas within the study area in Michigan. The En-

HIGHLIGHT

The recreational benefits of Lake St. Clair are estimated at $200 million (USD) on the Michigan side alone.

vironment Canada's Environmental Sensitivity Index atlas shows a total of 121 marinas within the study area in Ontario[30]. A current study of the economic benefits of recreational boating to the Great Lakes under the John Glenn Bill of the Water Resources Development Act of 2000 is underway. This document should shed more light on the binational economic impacts of recreational boating on the Lake St. Clair region.

Southeast Michigan[31]

St. Clair County is located in the southeastern part of the lower peninsula, bordered by Lake Huron on the northeast, the St. Clair River on the east and Anchor Bay and Lake St. Clair on the south. The county is 734 square miles in size. Farms occupy about 40 percent of the land, equally divided between crops and livestock. Manufacturing activity includes auto-related products, plastics, metal forging and stamping, and non-electrical machinery.

Macomb County is the ninth smallest of Michigan's 83 counties (with 482 square miles), yet it ranks third in population. Among the county's 27 municipalities are included three of the ten largest communities in Michigan: Warren (3rd), Sterling Heights (6th) and Clinton Township (10th). Manufacturing is Macomb County's leading industry, employing roughly one-third of the workforce. Major manufacturers alone have invested over $2 billion in the county since 1990.

Wayne County is the nation's eighth largest county and its two million residents make up almost half (46.27 percent) of the seven-county metropolitan Detroit region. Its forty-three local communities range from Detroit, the nation's seventh largest city, to small towns. It is home to the auto industry and is expanding its diversity to the point that it is now the center of the fastest growing high tech corridor in the United States. It is also southeast Michigan's transportation link through its border to Canada and its two international airports.

FACT

Wayne County is the nation's eighth largest county and its two million residents make up almost half (46.27 percent) of the seven-county metropolitan Detroit region.

Oakland County's population grew 10.2 percent between 1990 and 2000, while the state of Michigan grew 5.1 percent. 13.4 percent of all people employed in Michigan work in Oakland County. Thirty-eight percent of the Fortune 500 companies do business in Oakland County, and it is Michigan's leading center for international commercial activity with 565 foreign-owned firms from 25 countries. More than 59,250 businesses and government agencies are located in the county, including 1/3 of Michigan's R&D firms. There are more than 89,000 acres of park land and 450 lakes.

Lapeer County ranks as the 23rd most populous among Michigan's 83 counties with 74,768 residents. The county consists of 18 townships, 7 villages, 2 cities, encompasses 666 square miles, and is generally balanced between farms, industry, retail and residential.

Sanilac County's early existence depended greatly upon the lumber industry. As the lumbering era ended, agricultural activities took precedence and continue to be the primary land use in the county. Sanilac County is rural/agricultural, with many small cities and villages. Approximately 72 percent of the land is devoted to agricultural production. The county is the state's top dairy product producer and ranks high in output of sugar beets, corn, oats, hay, wheat, barley, soybeans, dry beans, and cattle. Manufacturing includes rubber products, metal and plastic auto parts, and conveyors. Sugar and pickles are also produced in the county.

Table II C - 1, Southeast Michigan Labor Market and Industry Employment (1997)[32]

Wage and Salary Employment	Totals
Mining	1100
Construction	89000
Manufacturing	495600
Private Service	1465200
Transportation, Communication and Utilities	100700
Wholesale Trade	135500
Retail Trade	404400
Eat and Drink	141600
Other Retail	262800
Finance, Insurance and Real Estate	122200
Depository Institutions	38300
Other Finance, Insurance and Real Estate	83900
Services	702400
Business, Engineering and Management	263800
Health Services	207600
Other Services	231000
Government	296400
Federal	33000
State and Local	263400
Education	160900
Other State and Local	102500
TOTAL	**2347000**

Another measure of the U.S. economy is the Gross Domestic Product (GDP) by industry. Table II C - 2 shows the GDP by industry for Southeast Michigan.

Table II C - 2, Real Gross Domestic Product for Michigan (2000)[33]

Category	$ Million (USD)
Total Gross State Product	323717
Private Industries	290273
Agriculture, Forestry, Fisheries	2886
Mining	853
Construction	16239
Manufacturing	82135
Durable Goods	62368
Nondurable Goods	19767
Transportation and Utilities	20823
Transportation	8668
Communications	5024
Electric, Gas, Sanitary	7131
Wholesale Trade	24362
Retail Trade	30322
Finance. Insurance, Real Estate	48372
Services (excluding Health Services)	44518
Health Services	19461
Government	33444

Southwest Ontario[34]

Windsor is the major employment center for the census metropolitan area, averaging more than 90 percent of the jobs over the past twenty years. The automotive sector in the Windsor-Essex region accounts for approximately 70 percent of the region's domestic product and employs over one-third of the manufacturing labor force. In addition, agriculture is an important mainstay of the resident population throughout the Ontario portion of the watershed. As shown in Table II C - 3 and Table II C - 4 below, manufacturing and the support services to manufacturing and resident populations play a large part in the economies of Southwest Ontario. For instance, 90 percent of Essex County is agricultural land and it produces 14 percent of Canada's gross domestic product in agriculture.

FACT
Windsor is the major employment center for the census metropolitan area, averaging more than 90 percent of the jobs over the past twenty years. The automotive sector in the Windsor-Essex region accounts for approximately 70 percent of the region's domestic product and employs over one-third of the manufacturing labor force.

Over the next twenty years, Windsor will continue to provide a significant amount of new employment opportunities within the census metropolitan area. Significant employment growth is anticipated to occur in both the automotive industry and in the tourism and hospitality sector. Total employment is expected to be close to a projected 134,553 jobs by the year 2016. 1996 employment projections identify employment land needs between 600 to 1,270 acres (243 to 514 hectares) over the 1996-2016 twenty-year planning period. Major employers within Windsor are clustered in manufacturing and commercial nodes across the city. It is anticipated that this trend will continue with additional nodes being developed to accommodate new and expanded employers particularly in the Forest Glade and Devonshire Planning Districts.[35]

Table II C - 3, Southwest Ontario Employment Level by Industry (2000)[36]

Wage and Salary Employment	Totals
Agriculture	30000
Resources (Forestry, Fishing, Mining, Oil, Gas)	3000
Manufacturing	162000
Construction	45000
Distributive (Transportation, Warehousing, Utilities, Wholesale Trade)	67000
Finance, Professional and Management (Finance, Insurance, Real Estate, Management)	92000
Information, Culture and Recreation (Publishing, Media, Telecommunications, Arts, Recreation)	30000
Retail Trade	87000
Personal Services (Accommodations, Food Services, Other Services)	83000
Education	48000
Health and Social Assistance	85000
Public Administration	24000
All Industries	757000

Another measure of the Canadian economy is its respective GDPs by industry. Table II C - 4 shows the GDP by industry for Province of Ontario.

Table II C - 4, Real Gross Domestic Product for the Province of Ontario by Industry (2000)[37]

Category	$ Million (CDN)
Goods Producing Industries	122260
Primary Industries[38]	7632
Utilities	10262
Construction	18485
Manufacturing	85881
Services Producing Industries	269393
Wholesale and Retail Trade	47084
Transportation and Warehousing	16035
Information and Culture (including Telecommunications)	16712
Finance, Insurance, Real Estate, Rental and Leasing	82450
Professional, Scientific and Technical Services	20085
Administrative and Other Support Services	9137
Educational Services	17430
Health Care and Social Assistance	21076
Arts, Entertainment and Recreation	3599
Accommodation and Food Services	8287
Other Services (excluding Public Administration)	8339
Public Administration	19159

II. D. Land Use

II. D. 1. Planning Framework

United States Planning Framework

Land use planning in the U.S. is remarkably decentralized. All U.S. states have their own planning and zoning laws based on federal law and have delegated responsibility for land-use controls to local governments (i.e., counties and municipalities). State planning laws authorize local governments to develop and adopt comprehensive plans and state zoning laws enable local governments to develop zoning regulations. In Michigan, as in all of the Great Lakes states, land use planning authority is delegated to the smallest unit of government, typically a city, village or township–a practice known as "home rule."

FACT

In Michigan, as in all of the Great Lakes states, land use planning authority is delegated to the smallest unit of government, typically a city, village or township—a practice known as "home rule."

The distinction between plans and regulations is an important one. The comprehensive plan is concerned with the long-term use, development and conservation of land and the relationship between local objectives and overall community and regional goals. Zoning ordinances include both a map that divides a local jurisdiction into districts and a set of regulations that determines the use of the land and the type of buildings allowed on the land in each district or zone. In other words, plans set forth goals to be achieved, whereas regulations are a means by which to reach these goals.

Theoretically, zoning is an important tool for achieving the goals set forth in planning. In the U.S., however, much - if not most - of land-use planning is not planning but zoning, which was developed as a tool to segregate different land uses. Michigan does not require zoning to be consistent with a comprehensive plan. While most communities around Lake St. Clair have comprehensive plans, zoning ordinances rather than comprehensive plans, carry the force of law and there is no legal requirement for consistency between the two in Michigan (See Section VI. C. 1 for more information on community master plans) In addition to zoning regulations, which determine what type of development can go where, local governments may also use subdivision regulations, which determine how the development will take shape within a given zone (e.g., how a larger piece of land will be divided into smaller units or lots, including lot locations and shapes, street patterns, location of parks and infrastructure needs, such as schools, streets, water and sewer lines, utilities, storm drainage, etc.).

HIGHLIGHT

In the U.S. region around Lake St. Clair, the coupling of home rule and the primacy of zoning has resulted in a system of land use "planning" that is characterized by intense competition among local governments to maximize their tax base by encouraging development and sprawling urban development.

In the U.S. region around Lake St. Clair, the coupling of home rule and the primacy of zoning has resulted in a system of land use "planning" that is characterized by intense competition among local governments to maximize their tax base by encouraging development and sprawling urban development. (See Section II. D. 2. for more on land use trends).

State and federal constitutions enable courts to serve as a higher level of authority for land-use planning, but only to ensure that local governments operate in a legal and constitutional manner, (e.g., appeal against a local decision) not to coordinate policy, although some states have legislation providing for greater planning coordination (see "state roles" below).

Planning Roles and Responsibilities:
Binational

The International Joint Commission (IJC) is a binational body created under the Boundary Waters Treaty of 1909 to prevent and settle disputes between the United States and Canada regarding the use of boundary waters, specifically those relating to water and air pollution and the regulation of water levels and flows. Geographically, this mandate includes the boundary waters themselves as well as their upstream tributaries. The IJC is comprised of six commissioners, three U.S.-appointed and three Canadian-appointed, and is supported by a complex organizational structure of boards and reference groups that deal with the diverse issues in which the IJC is involved. The IJC functions in an advisory capacity to the federal governments of the United States and Canada. The IJC has a single regional office in Windsor, Ontario created solely for overseeing implementation of the U.S.-Canada Great Lakes Water Quality Agreement of 1972 (the Agreement) and its 1987 Protocol, which calls for the U.S. and Canada, as parties to the IJC, to "restore and maintain the chemical, physical and biological integrity of the waters of the Great Lakes Basin Ecosystem." The IJC does not have a specific board dedicated to habitat issues, but habitat and biological diversity is-

FACT

The International Joint Commission (IJC) is a binational body created under the Boundary Waters Treaty of 1909 to prevent and settle disputes between the United States and Canada regarding the use of boundary waters. The Great Lakes are a major focus.

sues are addressed indirectly through activities focusing on water quality, air quality research and emerging issues and priorities. The 1987 Protocol commits the two governments to develop and implement Remedial Action Plans (RAPs) for 43 Areas of Concern (AOC) within the Great Lakes that have experienced significant degradation.

Three AOCs are within or adjacent to Lake St. Clair: Clinton River, St. Clair River and Detroit River. Each of AOCs has a RAP and a corresponding Public Advisory Committee, which leads efforts to restore the areas beneficial uses that have been impaired. In each of these AOCs, "loss of fish and wildlife habitat" is one of the noted impairments that must be restored in order to remove the area from the list of AOCs. In the Clinton River Area of Concern, loss of fish and wildlife habitat is"mostly attributable to urban and suburban sprawl, and the activities which accompany these phenomena."

Most AOCs do not have specific criteria or targets for restoring the areas impaired uses. The Clinton River Public Advisory Council is taking steps in this direction. With support from a grant from the Michigan Department of Environmental Quality, the Clinton River Public Advisory Council is working to develop restoration criteria that will be used to determine when the Clinton River has recovered to the point that it can be delisted as an Area of Concern. The guidelines and recommendations in this Lake St. Clair Coastal Habitat Assessment will be useful in this effort. More information about the Clinton River AOC is can be found at *www.ijc.org/rel/boards/annex2/tables/clinton.html* and at *www.epa.gov/glnpo/aoc/clintriv.html*

The Detroit and St. Clair Rivers are also AOCs and flanking the Lake itself, directly impact and are impacted by what happens in and around Lake St. Clair. Loss of fish and wildlife habitat is among the beneficial use impairments in these AOCs as well. More information about each of the AOCs is found at *www.epa.gov/glnpo/aoc*.

The Great Lakes Fishery Commission (GLFC) is another binational entity with responsibilities that affect Lake St. Clair. Like the IJC, the GLFC advises the two federal government, but the GLFC is focused more on fisheries issues. Although it has an aquatic focus, the GLFC might advise the governments on land use activities to the extent that such activities negatively impact fisheries habitat.

GAP

There is no U.S. federal land use policy and there are no explicit U.S. federal land use planning laws other than those that enable states to engage in planning and zoning.

U.S. Federal Land Use Planning

There is no U.S. federal land use policy and there are no explicit U.S. federal land use planning laws other than those that enable states to engage in planning and zoning. However, a number of federal environmental protection laws, as well as programs to fund transportation and other public infrastructure, such as schools, water supply and treatment, can have a direct impact land use planning in coastal areas.

The major federal agencies with a direct interest in coastal habitat conservation and restoration through their management or regulatory responsibilities are described in above in Section II.A.1 and listed in Table II A 1 - 1 on page 15. The federal role is not land use planning, per-se, but their activities directly and indirectly influence planning through regulating and permitting uses, standard-setting, giving financial and technical assistance to states and local governments, as well as directly managing federally-owned lands.

The federal Coastal Zone Management Act and the Endangered Species Act have particular relevance to coastal habitat protection and restoration.

U.S. Regional/Multi-State Land Use Planning

There is no entity with authority to plan for land use on a multi-state or regional level. However, improved coordina-

CASE STUDY
Coastal Zone Management Program

The federal Coastal Zone Management Act of 1972 (CZMA) is the most significant U.S. federal policy affecting land use planning in coastal areas. The CZMA established the national Coastal Zone Management Program. The National Oceanic and Atmospheric Administration, part of the U.S. Department of Commerce, administers the program, which provides financial and technical assistance to coastal states to develop and implement their own coastal zone management programs. Michigan has participated in the federal Coastal Zone Management Program since 1978.

"Federal consistency" provisions of the CZMA require federal actions likely to affect land, water or natural resources in the coastal zone to be consistent with the state's coastal zone management program. The activities need not occur in the coastal zone to trigger consistency, only to affect coastal resources. Cumulative and secondary effects are also considered.

The CZMA allows each state to define its "coastal zone," which varies considerably from state to state. With some exceptions, Michigan's coastal zone includes only that area 1,000 feet landward of the highwater mark. Like the other Great Lakes states, Michigan's coastal program is "networked," which means that it does not have its own set of rules and regulations, but rather integrates all relevant existing state policies that impact coastal development, management and protection under the rubric of a single coordinated program.

The CZMA gives states broad flexibility, but requires each state plan to include the protection of significant natural systems such as wetlands and beaches; priority consideration for coastal-dependent uses; and orderly processes for siting energy and other major facilities.

While much of the available funding is issued to fund state programs, about one third is passed on to local communities and non-profits as matching grants for projects that lie within the coastal zone. Funds may be used for a variety of planning activities, including feasibility and natural features studies as well as low-cost construction projects including resource protection, trails, interpretive displays and scenic overlooks.

CZM grants in Michigan have helped protect and restore shoreline habitat, water quality and other nearshore features. Since 1997, the Michigan coastal program has issued more than 45 grants to some 20 plus agencies and local communities in the Lake St. Clair area, totaling approximately $1.2 million. Most of these projects had some natural area or habitat protection component. One of these is the St. Clair County Community Information System (*http://cis.co.saint-clair.mi.us*), which provides access to a specialized set of data related to development and management of resources along the county's urbanized shoreline.

In 1990, CZMA reauthorization added a new provision (Section 309) to encourage coastal states to enhance and improve coastal resources. MDEQ undertook a series of assessments of coastal issues, each of which identified the cumulative and secondary impacts of coastal development as Michigan's highest priority. The assessments further found that problems such as coastal habitat fragmentation, loss of agriculture and forest lands, increased imperviousness and stormwater runoff, and increased development in coastal hazard and sensitive areas could be ameliorated through better coordinated coastal land use planning.[39]

tion of state policies and programs related to planning and resource protection is within the purview of the Great Lakes Commission. Established by joint legislative action of the Great Lakes states in 1955 and granted congressional consent in 1968, the Great Lakes Commission is an interstate compact agency that guides, protects, and advances the common interests of the eight Great Lakes states in the areas of regional environmental quality, resource management, transportation, and economic development. The Commission comprises state officials, legislators, and governors' appointees from Illinois, Indiana, Michigan, Minnesota, Ohio, Pennsylvania, New York, and Wisconsin. Though technically an advisory body, the Great Lakes Commission is the only regional organization with a statutory mandate to represent the collective views of the eight Great Lakes states and carries significant weight as the voice of the Great Lakes states, both within the region and nationally.

State Land Use Planning

There is no state land use or planning agency in Michigan. However, in 2002 the state legislature passed three laws that amended existing state enabling legislation requiring local governments to plan and coordinate their planning activities[40]. These are described under "local planning" below.

Like many other states, Michigan has two primary agencies that address environmental protection and natural resource management. The Department of Natural Resources (DNR) is the lead agency for administering natural resource programs related to habitat conservation and restoration. Importantly, most of the considerable acreage of land owned by the state of Michigan within the project area is managed by the DNR. As such, the DNR is the key state agency in the stewardship of Lake St. Clair coastal habitat. The Department of Environmental Quality (DEQ) is the primary agency responsible for implementing and enforcing environmental protection laws, including the state's own laws as well many federal environmental

protection laws that are delegated to the state by the USEPA. In Michigan, the coastal management program is administered by the DEQ.

U.S. Local (Municipal) Land Use Planning

There are approximately 201 cities, towns/townships, villages and named unincorporated areas in the project area, including parts of Macomb, St. Clair and Wayne Counties. In southeast Michigan, townships occupy a six square mile jurisdiction, which may be truncated by cities and villages with their own boundaries, which are usually less geometric. In addition to general purpose governments (cities, townships and villages), each community also has any number of special districts which may have an impact on land use planning–from drain commissioners that regulate the impacts of development on streams to park districts that develop and maintain local parks and many in between. Both special districts and general purpose local governments are faced with different land-use issues based on their size, location, economic base, environmental resources, and demographic attributes and they respond differently to those problems, using any combination of tools and techniques noted earlier, within the limits imposed by state and federal land-use restrictions. Because Michigan is a "home rule state" all planning decisions ultimately falls to the smallest units of government (city, township or village), which determine how land is used within their jurisdictions--which lots will or will not be developed, when they will be developed, and how.

HIGHLIGHT

The Michigan legislature has passed a series of laws that require townships, cities, villages and counties to coordinate their planning and to provide for open space preservation in their local zoning ordinances.

The 2001 coordinated planning laws passed by the state have several important provisions for local planning:

- all municipal jurisdictions must notify neighboring jurisdictions and other governmental entities of the their intention to amend, revise or create a totally new plan
- the notice must request the recipient's cooperation in the planning process and ask for the recipient's comments once a draft plan is created
- the neighboring jurisdictions and the regional planning commission must also send a copy of their comments to the county government within which the proposing municipally resides
- the county then provides comments and a two-part consistency review to a) determine whether the proposed plan is inconsistent with the neighboring jurisdiction's plan, and b) determine whether the proposed plan is inconsistent with the county's plan, if such a county plan exists.

FACT

There are approximately 201 cities, towns/townships, villages and named unincorporated areas in the project area, including parts of Macomb, St. Clair and Wayne Counties.

Importantly, Michigan law now requires that every community have a land use master plan. The communities must evaluate their plan every five years to determine its continued relevancy to the community. Plans can incorporate natural features inventories and other ecological concerns. As referenced above, the Coordinated Planning Acts require neighboring local governments to consult and share plans with each other, but do not require them to plan jointly.While the coordinated planning legislation requires local governments to consult and share plans with each other, they do not require them to develop or implement these plans jointly (with shared goals and objectives), which falls short of planning that is truly coordinated. An analogy might be the difference between telling your neighbor what you're going to do and doing it on your own versus making a plan and executing it with your neighbor. Importantly, there is no reliable funding source for development/updating of local comprehensive

FACT

Major metropolitan regions in the U.S. are organized into regional councils of governments (COGs). The Southeast Michigan Council of Government (SEMCOG) represents seven counties of the southeast Michigan region. There are no equivalents to COGS in Canada.

plans, which could also be the "carrot" for interjurisdictional planning.

In 2001, the Michigan legislature also passed a series of laws that require all cities, villages, counties, and townships with populations over 1,800 to provide an open space preservation option in their local zoning ordinance.[41]

Local governments in all the major metropolitan regions and many rural areas in the U.S. are organized into regional councils of governments or planning commissions. The Southeast Michigan Council of Government (SEMCOG) represents seven counties of the southeast Michigan region (Livingston, Macomb, Monroe, Oakland, St. Clair, Washtenaw, and Wayne) including the three that directly border Lake St. Clair (Macomb, Wayne and St. Clair). SEMCOG functions in an advisory and coordinating capacity to local governments and is an important repository of socio-economic and environmental data for the region. Much of the U.S. socio-economic data used in this plan was provided by SEMCOG (*www.semcog.org*).

Canadian Planning Framework

Federal Land Use Planning Roles and Responsibilities

Canada is a federation of ten provinces and two northern territories. When it comes to general responsibilities for protecting natural resources and the environment, the institutional framework is somewhat similar to that in the U.S. Although there is general constitutional division of authority between the federal and provincial governments, environmental protection and management is a shared responsibility. Also, like the U.S. the Canadian federal government does not have a specific mandate or function in land use planning, but does have an influence through infrastructure funding programs as well as environmental and natural resource protection programs.

Provincial Land Use Planning Roles and Responsibilities

The provincial government is responsible for most matters that affect the planning and use of land in Ontario, including the management of Ontario public lands and management of the province's natural resources. The Planning Act of 1990 gave municipal councils the authority to regulate land use[42]. With a few exceptions, authority for most land-use planning decisions has been delegated by the province to one or both levels of municipal government. Lambton County, the Corporation of the Municipality of Chatham-Kent, Essex County and the City of Windsor, are the municipalities responsible for land use planning in the project area.

FACT

The provincial government is responsible for most matters that affect the planning and use of land in Ontario, including the management of Ontario public lands and management of the province's natural resources.

The Planning Act establishes policies that affect settlement and the management of growth within which municipal planning and development can proceed. The Provincial Policy Statement (PPS) is a complementary policy document to the Planning Act, which sets out the Ontario government's interest in land use planning and development and provides policy direction on key matters that are deemed to be of provincial interest.

Section 3 of the Planning Act requires all local government bodies that exercise planning authority to "have

regard to" the policies set forth in the PPS. The "have regard to" clause does not require rigid conformity to provincial policies. In practice, it is more of a process that must be followed. As part of a review of the provincial planning system in summer 2004, the province is proposing changing the "have regard to" statement to "be consistent with" which would provide a standard that must be adhered to in reviewing planning documents[43]. Although environmental interests are expressed as important principles in the Planning Act and the PPS, land-use planning and official plans are more concerned with the developed landscape rather than the natural environment. In Ontario, as in the U.S., land-use planning based on the primacy of natural ecosystems is still some way off, both in principle and reality.

Land uses and the planning and development process are also influenced by a large number of other laws and regulations pertaining to construction standards, environmental standards for infrastructure, protection of natural resources, etc. The agencies that administer these programs are described in Section II. A. 2.

The provincial government may prepare its own plan for any part of the province. Such provincial plans take precedence over the plans of municipalities, which are required to amend their own documents to conform to the provincial plan. Only two such plans have been passed since the legislation was introduced in 1973–the Niagara Escarpment Plan and the Parkway Belt West Plan–the latter which restricts urban development on a corridor around the rapidly growing Greater Toronto Area (GTA).

HIGHLIGHT

The Ontario Municipal Act sets forth the terms and procedures for the province when establishing a municipal government. The Planning Act, in contrast, is the key piece of legislation governing growth and settlement within the Province.

Municipal Land Use Planning Roles and Responsibilities

Seven municipalities have jurisdictions that border Lake St. Clair and the St. Clair River shoreline. (see Section II.A.2). As directed and empowered by the Planning Act, municipalities develop official plans, zoning bylaws and other controls, such as stormwater management plans that lessen the environmental impacts of human activities and community growth.

Ontario's municipalities are created and guided in their essential operations by the Planning Act. The Municipal Act sets forth the terms and procedures for the province when establishing a municipal government. The Planning Act, in contrast, is the key piece of legislation governing growth and settlement within the Province. Among major elements, the Act:

- establishes the role and interest of the province in planning matters;
- sets the framework for establishing local planning administration;
- sets the framework for planning instruments and controls that can be employed by local governments, including official plans, zoning, and subdivision control;
- establishes public consultation requirements;
- defines the role of the Ontario Municipal Board with respect to the planning approval process.

The Planning Act enables all municipalities and requires regional municipalities to prepare Official Plans, which establish formal goals, objectives and policies for development and "to manage and direct physical change and the effects on the social, economic and natural environment of the municipality or part of it, or an area that is without municipal organization." Official plans must be formally adopted by the respective regional or local municipal councils in Ontario before being forwarded to the provincial government for approval. In a few instances the provincial approval authority for lower tier municipalities has been delegated to the regional level of government, where that exists.

In Ontario, a municipal plan is not binding on the province, although any ministry is required to "consult with, and have regard for, the established planning policies of the municipality" before carrying out any activity. Generally, once

HIGHLIGHT

The Ontario Planning Act enables all municipalities and requires regional municipalities to prepare Official Plans, which establish formal goals, objectives and policies for development and "to manage and direct physical change and the effects on the social, economic and natural environment of the municipality or part of it, or an area that is without municipal organization."

a plan has been finally approved by the Province, no local controls or public works may be carried out that do not conform to the plan.

Once the regional Official Plan has been approved, local municipalities are required to amend their own official plans to bring them into conformity with the regional plan. Municipal councils are required to review their plans at least every five years to ensure that their basic principles and goals are still valid. The Ministry of Municipal Affairs and Housing serves to assist and review the activities of municipalities, including land use planning.

An approved municipal plan has little effect by itself and must be implemented by various regulations (zoning by laws). Implementation takes the form of ensuring that no uses of land are allowed that do not conform with approved planning policies, but nothing is legislated to actually seek the achievement of specific planning objectives. Thus the relations to planning and zoning in Ontario is similar to that in the U.S.

Official plans can be and are frequently amended to allow for changes in designated land uses to accommodate growth and other changes that municipal politicians may deem appropriate. In growing municipalities, pressure for amendments from politicians wishing for development growth and from developers can significantly alter the original goals of the official plan for a municipality. Finally, official plans require periodic renewal as mandated by the province.

Zoning

Implementation of plannin gpolicies mostly involves the control of privately initiated evelopment and generally take the form of municipal zoning bylaws. Zoning bylaws establish several types of residential, commercial, industrial, and other zones according to density or character of development. They must be consistent with the municipal official plan and state exactly what uses are permitted in different parts of the community, including where buildings may be located, the types of uses and dwellings permitted, standards for lot size, parking requirements, building height and setback distances from the street.

FACT

In Ontario, zoning bylaws must be consistent with the Official Plan, whereas in Michigan zoning does not have to be consistent with comprehensive plans.

As in the U.S., the Canadian zoning system was developed originally to protect neighborhoods from undesirable uses and although it provides a measure of certainty and predictability, it also has drawbacks as a development control device. In growing municipalities, zoning bylaws tend to be frequently amended simply because zoning is often not flexible or creative enough to regulate new development.

Subdivision control in Ontario has been delegated to most regional municipal governments where they exist. Subdivision control ensures that land is suitable for its proposed use and that it conforms to municipal planning policies. It also serves to protect the community from inappropriate development that may be premature or may put undue strain on community finances or services (e.g., water supply or sewage treatment facilities).

FACT

As in the U.S., the Canadian zoning system was developed originally to protect neighborhoods from undesirable uses and although it provides a measure of certainty and predictability, it has been criticized for permitting sprawling development and unnecessary habitat fragmentation and destruction.

Municipal councils can also create a "committee of adjustment" at the local level to hear cases of minor zoning variances. Similar to zoning boards in the U.S., these committees hear cases where a proposed development or planning activity varies from the zoning by laws. If applicant doesn't like committee's decision, it can appeal to Ontario Municipal Board.

The Ontario Municipal Board

The Ontario Municipal Board (OMB) is a quasi-judicial body of last resort and has broad powers to resolve disputes on planning matters. Since it is a court of last appeal and resort, and since it can rule on land use, including overturning council decisions, as well as matters of process, the OMB is a powerful entity in planning and is regarded as the final planning authority in Ontario. The Planning Act lays out the framework describing who can refer planning matters to the OMB and when they can do so in the planning process. Matters that typically end up before the board can relate to official plans, official plan amendments, zoning, plans of subdivision and even minor variances from zoning provisions. The elevated requirement to "be consistent with" the PPS as discussed above would have particular implications for the Ontario Municipal Board, which would then have a standard for measuring whether a planning provision is in fact consistent with the PPS.

II. D. 2. Land Use Trends

C-CAP data show that 23 percent of the project area or approximately 175,000 acres (70,819 hectares) is "developed" land, including both high intensity and low intensity developed lands. Most of this development occurs in the Michigan portion of the project area, in Detroit and its northern suburbs[44]. Analysis of the C-CAP land cover data for 1995 and 2000 show an net increase of 4,800 acres (1,942.5 hectares) in total high and low intensity development within the project area and a commensurate reduction in all non-developed land categories[45] (See Section IV. A. 1. & 2.).

HIGHLIGHT

C-CAP data show that 23 percent of the project area or approximately 175,000 acres (70,819 hectares) is "developed" land, including both high intensity and low intensity developed lands. Most of this development occurs in the Michigan portion of the project area, in Detroit and its northern suburbs.

U.S. Land Use Trends

The collective impacts on habitat from socio-economic activities are perhaps most telling through changes in land use. The growth in population, households, employment and income discussed earlier in this section are four fundamental factors driving land use change on the U.S. side of Lake St. Clair. How these socio-economic trends play out on the landscape is significantly influenced by a variety of government policies - primarily those related to local planning and zoning, transportation infrastructure, and sewer and water service. These policies favor low-density, financially segregated residential development and strip commercial development on previously undeveloped lands the outskirts of older communities. Other social and policy dynamics also influence land use, including federal tax subsidies for mortgage interest and property taxes, school funding and quality, crime, public safety, urban design, private property rights and personal lifestyles. All of these issues and more come together through a U.S. land use policy that is characterized by home rule and the prominence of zoning over comprehensive planning as discussed in the previous section (See Section II. D. 1.).

GAP

There are no comparable or complete data sources on land use and land use trends for the project area. Land cover data for the project area was used as a surrogate and can provide a sense of predominant land uses and trends.

While C-CAP provides land cover data for the project area, there is no land use data specific to the project area. The Southeast Michigan Council of Governments (SEMCOG) tracks land use change for the region's 4,600 square miles and seven counties, using aerial photography and computer mapping every five years. The SEMCOG land use data covers the project area and beyond and provides changes within the counties in the study area and the larger U.S. region. The following discussion of the U.S. side of the study area is based on the SEMCOG land use change monitoring and analysis.[46]

Land Use Change in Southeast Michigan 1990-2000

From 1990 to 2000 the area of land developed in Southeast Michigan increased by 159,300 acres or 17 percent. Of this, 121,000 acres were converted to residential development, representing 26 percent of the new development, while 38,200 acres (24 percent of the new development) were developed for non-residential purposes (e.g., retail stores and surrounding land, industrial facilities, airports, golf courses, etc). Of the 159,300 acres developed, 140,800 were former agricultural lands, resulting in a 13 percent loss in the region's agricultural land. Put another way, conversion of agricultural land to development represented 88 percent of new development during the decade. These figures demonstrate that most new development is a direct result of agricultural land conversion, as relatively little new development occurs on other types of land.

SEMCOG data indicate that from 1990 to 2000 the population increased 5 percent, the number of households increased 9 percent and employment grew by 14 percent, while the amount of land developed increased by 17 percent. The disproportionate rate of new development is attributable to a variety of factors, including population change, household density shifts (residents per household), household growth (number of houses built), development density shifts, and increases in employment rates and incomes.

HIGHLIGHT

Conversion of agricultural land to development represented 88 percent of new development in southeast Michigan between 1990 and 2000.

Increases in households and incomes affect the rate and type of land development. More households are being built to serve fewer people as children leave home to form their own households and people are living longer and can afford to live in separate households. In 2000, the average household had 2.58 persons compared from 2.66 persons in 1990. The reduction in household size means that more houses are needed to serve the same number of people and more houses require more land.

Increased incomes also affects land development rates and patterns. During the 1990s, after inflation, per capita incomes rose 16 percent. Higher incomes support higher rate of household formation. Again, people who make more money are more likely to be able to afford to live on their own–young adults move away from home earlier and the elderly can afford to stay in their homes. More households and higher incomes resulted in more land to be developed to provide stores restaurants and other businesses to service those homes.

By far the most significant factor affecting the rate of land development is the decrease in the density of new development. SEMCOG estimates that 43 percent of the new development between 1990 and 2000 was due to this factor alone. Between 1990 and 2000 the average density of housing units was 1.25 units per acre compared to 2.84 units per acre from the previous decade. If the 5 percent increase in population were accommodated at the higher density of

the 1980s, the amount of land developed in the 90s would have been only 43,011 acres, and 116,000 acres would have remained undeveloped. Low density development magnifies the impact of actual population, household and income growth. The decrease in development density means that the same number of people occupied over three times as much land area than they would have had development occurred at the rate of the previous decade.

HIGHLIGHT

The decrease in development density means that the same number of people occupied over three times as much land area than they would have had development occurred at the rate of the previous decade.

Lower density development results from a number of factors. Strong preferences for larger homes on larger lots are not only a result of rising income levels, but are reinforced by community master plans, zoning regulations, and building codes that require land use types to be separated, minimum lot sizes and setbacks much greater than were required in traditional neighborhoods build prior to World War II. One only needs to look at older neighborhoods compared to newer neighborhoods to see the difference in land consumption. Older neighborhoods were built on narrower streets and narrower lots, with houses closer to each other, closer to sidewalks and generally had smaller rooms and smaller garages behind the homes. They also required fewer roads and boulevards because a variety of shops were usually with close proximity.

Other factors such as transportation access, locations of available land and private property rights can facilitate or deter development, but are not primarily responsible for the amount of land development.

Urban expansion has resulted in significant loss of agricultural lands. SEMCOG data indicate that between 1990 and 2000, the three counties bordering Lake St. Clair lost 63,900 acres (25,859 hectares) of agricultural land--a 15.4 percent loss. While some losses are due to economic factors in farming, the agricultural land losses are primarily due to land development.

HIGHLIGHT

The pattern of scattered, low-density development in outlying areas, commonly known as "sprawl" results in excessive fragmentation of remaining open space and natural habitat areas.

The fundamental implication for habitat is that once open space and agricultural lands are developed, those lands are no longer available for conservation or restoration. The pattern of scattered, low-density development in outlying areas, commonly known as "sprawl" results in fragmentation of the remaining open space and natural habitat areas–a pattern that is likely to continue into the foreseeable future. This heightens the urgency to conserve existing habitats around Lake St. Clair.

Canadian Land Use Trends

On the Canadian side of the project area, an exception has been urban expansion in and around Windsor. As Ontario's and indeed Canada's southernmost point with a relatively long (by Canadian standards) growing season, the land around Lake St. Clair is among Canada's prime farmland. From this geographic standpoint, it is easy to see why Ontario has been prudent about keeping the its prime agricultural land in agricultural use.

Western Ontario is changing in ways that are transforming the local economy, communities, and landscape of this area of the province. Western Ontario is the province's agricultural heartland and generates more than half of Ontario's gross farm revenue. Lands converted to agriculture during the 1800s have largely remained in agriculture as farming remains the mainstay of the region (75 percent is in farmland). Culturally, agriculture is still the center of many communities[47]. Future land use trends show the number of farmers decreasing, while agricultural production intensity and

the number of non-farming residents in rural areas will increase. More traditional small family farms are becoming large modern operations with integrated production and distribution systems serving world markets. Lake St. Clair coastal wetlands were drained for settlement and agriculture between 1873 and 1968. By the mid 1960s nearly 40 percent of wetlands directly associated with the lake had been destroyed. Most were drained for agriculture[48]. Today, urban centers such as Windsor anticipate future expansion due to population and job growth as the automotive sector, petrochemicals, financial services, tourism and other industries are play an increasingly important role in the area's economy.[49]

HIGHLIGHT

Western Ontario is the province's agricultural heartland and generates more than half of Ontario's gross farm revenue. Lands converted to agriculture during the 1800s have largely remained in agriculture as farming remains the mainstay of the region.

Windsor-Essex County

Local planning responsibilities and related land use trend data in the three Canadian counties that boarder Lake St Clair (Essex, Chatham-Kent, and Lambton) are divided between local county and municipal government units and vary between counties. Of the three counties, Essex County has the highest population with a greater amount of urbanization and development adjacent to the Lake St. Clair. Essex is expected to have the largest population growth rate through 2028 at 19 percent, with Chatham-Kent and Lambton at 2 percent each.[50]

Ninety percent of Essex County is classified as Prime Agricultural Land (Class 1, 2 and 3 Soils, in the Canada Land Inventory)[51]. Windsor-Essex is known for its productive agricultural industry. Currently 92 percent of the land in the county is in agricultural use with 5 percent in urban infrastructure (roads and towns) and 3 percent remaining as natural lands[52]. The agricultural landscape is changing to one with fewer, larger farms. The consolidation of farms into larger operations resulted in a 32 percent decrease in the number of farms between 1986 and 2001. During the same period, Essex County experienced a 25 percent increase in farms greater than 400 acres in size.[53]

FACT

Essex County has the highest population with a greater amount of urbanization and development adjacent to the Lake St. Clair.

Scattered rural development has been a trend in less-developed areas presenting a variety of environmental problems. For example, groundwater contamination may occur when private septic systems fail or become overloaded in rural areas not serviced by public water supplies. Scattered rural development could be curtailed in favor of existing settlement areas, to preserve prime agricultural land and reduce the reliance on private sewage disposal systems. The County Plan has designated "settlement areas" along Lake St. Clair where growth will be encouraged in areas with full municipal service[54].

Commercial and industrial land is in short supply in the county. Essex County estimates that the existing 1,730 acres (700 hectares) of land designated for industrial land as of 2001 are insufficient for the County's needs over the next 20 years. It is estimated that an additional 300 to 400 hectares of land will be required for this purpose[55]. The City of Windsor projects that it will require an additional 243 to 514 ha of land over the next 20 years for industrial development. This is excluding the 200 to 400 hectares currently reserved for prospective large-scale industries in the municipality[56]. Recent provincial initiatives, including the introduction of "brownfield" legislation, may encourage the rehabilitation of former industrial or commercial sites, reducing the need for new development at the periphery of settlement areas.

Essex County has lost approximately 97 percent of its original wetland area and approximately 95 percent of its original forest cover[57]. The Essex Region Conservation Authority's Biodiversity Conservation Strategy has noted that de-

spite extensive clearing and settlement, Windsor-Essex remains Canada's most biologically diverse region. Windsor-Essex is located at the northern limit of the Eastern deciduous forest region and contains more rare and endangered species of plants and animals than any other part of Canada, including over 500 species of rare or endangered plants and animals. However, further rural development threatens some of the natural features that make Windsor-Essex unique[58]. The Essex Biodiversity Conservation Strategy is a long-term plan which will encourage protection and rehabilitation of natural areas within the county[59].

> **FACT**
> Windsor-Essex is located at the northern limit of the Eastern deciduous forest region and contains more rare and endangered species of plants and animals than any other part of Canada, including over 500 species of rare or endangered plants and animals.

In 1996 projections called for an additional 10,950 dwelling units in by 2016. Building rates exceeded these projections. To date, 75 percent of the projected need for the twenty-year planning period has been built. Accordingly, projections were modified and the new projections call for an estimated 96,000 dwelling units for the 1996-2016 planning period. Approximately 71 percent of all required units are projected to be low density, 17 percent medium density and 12 percent high density[60]. The amount of land that will be consumed is not known, but could be estimated based on the types (i.e., density) of development expected to occur if that data were available.

Beginning in the late 1990s, industrial land serviced with roads, water and utilities in the Windsor/Essex region had become scarce. As a result of the projected positive population, housing and employment growth, the City of Windsor's land supply was expected to decrease over the next twenty years. In May of 2002, the County of Essex, Town of Tecumseh and City of Windsor recognized the need for a cooperative solution and negotiated a boundary adjustment. The City of Windsor currently covers approximately 145.3 square kilometers including a 2003 transfer of lands from Tecumseh of 2,532 hectares. It is anticipated that the recent land transfer from the Town of Tecumseh will accommodate land supply needs for both employment and residential land use in the coming years[61].

Lambton County

The Official Plan for the County of Lambton estimates that county population will increase to 142,000 by the year 2016 with an increase in the total labor force to 73,000 by 2016. It is anticipated that all municipalities with in the county will experience some growth based on the availability of sewer, water and community services. The majority of growth is expected to occur in the western Lambton County area, which is comprised of the City of Sarnia, the Village of Point Edward, and the Townships of Moore and Sombra[62]. This area of the County is where the major employers are located along with the greatest concentrations of industrial and commercial activities. Petrochemical industrial land along the main highway running parallel to the St. Clair River will be centered in the western Lambton County area, with new development set back from the river. Rural areas in the county are anticipated to experience the lowest levels of growth. The plan also anticipates the need on average for 400 new dwelling units annually per year to the year 2016. Over half of the counties' total new population growth and additional housing unit needs will occur in western Lambton County.

> **HIGHLIGHT**
> Petrochemical industrial land along the main highway running parallel to the St. Clair River will be centered in the western Lambton County area, with new development set back from the river.

The majority of growth within the county will be directed to current Urban Centers and Urban Settlements. The northwest part of the county has the greatest service area and the greatest number of urban uses and employment op-

portunities. Rural and agricultural land use will continue as the major land use in the county. Only a limited amount of development is anticipated in the county rural areas.[63]

Chatham-Kent

Of the three counties in Ontario on Lake St. Clair, Chatham-Kent is the smallest in population and is expected to have the least amount of future growth. The Ontario Ministry of Finance estimates that at a medium growth rate that Chatham-Kent would grow by 3,500 persons to 116,300 over the twenty year period from 2001 - 2021. Under their high growth scenario Chatham-Kent would grow by 7,200 persons to 120,000[4648]. Based on the medium growth scenario, the demand for housing in Chatham-Kent over the next twenty years (2001-2021) is projected to be for about 6000 dwelling units of which 80 percent will be low density housing (single detached and semi-detached dwellings), 17 percent medium density housing (street and stacked townhouses, low rise apartments) and 3 percent high density housing (high rise apartments)[65]. It is not known exactly how much land this development is expected to consume.

It is expected that Chatham-Kent will maintain its basic rural character for the near future. The stated goal or objective of the Official Plan is to have the Urban Areas as focal points where residential, commercial and industrial development will be directed in the County. Some in-filling, additions and rounding out of existing municipalities and serviced hamlets will also occur. In privately serviced Rural Settlement Areas development will be limited to in-filling. It is intended that the majority of population growth will be accommodated within the county's seven Urban Centers.

Due to its proximity to Highway 401 and other major urban centers in Ontario and the United States, Chatham-Kent has developed a strong industrial land base. The municipality contains eleven industrial areas which are located either within or adjacent to its seven Urban Centers. The Chatham-Kent Employment Land Needs Analysis (technical study prepared in support of the Economic Development Strategy) found that while there is a sufficient supply of designated industrial land in Chatham-Kent to meet the projected 20 year demand, portions of those lands remain undeveloped because they do not meet the needs of the current industrial land market.

The Employment Land Needs Analysis indicated that while demand for industrial lands has been relatively weak throughout most areas of Chatham-Kent, those municipalities with industrial areas/business parks located in the corridors of 400 Series highways have experienced strong demand for employment lands in those areas. The Study indicated that over the twenty year (2001-2021) time horizon up to 131.5 hectares (325 acres) of designated employment land would be warranted in the Highway 401 Corridor at Bloomfield Road and Highway 40/Communications Road in addition to the lands available in the 401 South and 401 North Industrial Areas in Tilbury.[66]

FACT

The Municipality of Chatham-Kent encompasses a diverse range of parks, natural areas and recreation facilities, enhanced by the water-based recreation opportunities offered by the extensive shorelines on Lake Erie and Lake St. Clair, and the Thames and Sydenham River.

The Municipality of Chatham-Kent encompasses a diverse range of parks, natural areas and recreation facilities, enhanced by the water-based recreation opportunities offered by the extensive shorelines on Lake Erie and Lake St. Clair, and the Thames and Sydenham River. The County has 11,500 hectares of "provincially significant" wetland areas along Lake St. Clair. This includes the St. Clair National Wilderness Area, a globally important bird area. In pre-settlement times, it is estimated that over 60 percent of Chatham-Kent's landscape was wetland, 16 percent was forest and approximately 12 percent was tall-grass prairie. Agriculture in the region has reduced both wetlands and forest cover in Chatham-Kent to less than 4 percent each. Forest cover in Chatham-Kent is extremely low and is significantly less than pre-settlement levels and well below the Environment Canada Draft Framework Guideline of 30 percent. A strategy to protect natural areas is particularly important because of the fragmented nature of the natural features.[67]

Section II Endnotes

1. Myers, D.N., Thomas, M.A., Frey, J.W., Rheaume, S.J., and Button, D.T. 2000. Water quality in the Lake Erie-Lake St. Clair drainages. Michigan, Ohio, Indiana, New York, Pennsylvania, 1996-1998. U. S. Geological Survey, Circular 1203, 35 pp.

2. Environment Canada, 2004. Draft: The Lake St. Clair Canadian Watershed Technical Report: An examination of current conditions. December 30, 2003.

3. *Ibid*.

4. *Ibid*.

5. *Ibid*.

6. *Ibid*.

7. *Ibid*.

8. *Ibid*.

9. *Ibid*.

10. *Ibid*.

11. *Ibid*.

12. *Ibid*.

13. *Ibid*.

14. www.countyofessex.on.ca/history_restruct.html

15. Environment Canada, 2004, *op. cit.*

16. *Ibid*.

17. A riding is a constituency or electoral district in Canadian parliamentary politics.

18. Email Communication, Dave White, Walpole Island Heritage Center. July 19, 2004.

19. Population and household numbers in this section are derived from studies and reports produced by the Southeast Michigan Council Of Governments (SEMCOG). The Southeast Michigan region includes the cities, villages, townships, and counties, within the seven county area of Livingston, Macomb, Monroe, Oakland, St. Clair, Washtenaw, and Wayne Counties.

20. SEMCOG. Population and Households in Southeast Michigan,1990-2000. Southeast Michigan Council of Governments, July 2000.

21. SEMCOG, Population and Households in Southeast Michigan 1990-2001, December 2001.

22. The 2004 population and household data are based on SEMCOG estimates.

23. SEMCOG, Population and Household Estimates for Southeast Michigan, May 2004.

24. SEMCOG, 2030 Regional Development Forecast for Southeast Michigan: Population, Households, and Jobs for Cities, Villages, and Townships 1990-2030. October 2001.

25. Office of Planning, New Official Plan Draft, September, 2003, Municipality of Chatham-Kent, Chatham, Ontario.

26. City of Windsor, Planning Division, Windsor, Ontario Canada, October, 2002.

27. Ontario Ministry of Finance Projections 1999-2028, Toronto, Ontario, Canada 2000.

28. Ontario Ministry of Finance, Windsor-Essex: In Profile, Provincial Planning and Environmental Services Branch, Ministry of Municipal Affairs and Housing, 2003. Web site: www.mah.gov.on.ca/userfiles/HTML/nts_1_12605_1.html

29. Figures provided by the Sarnia Vessel Traffic Service, which monitors all traffic for Canada and the US transiting the Detroit and St. Clair Rivers.

30. *Environmental Sensitivity Data for the St. Clair River, Lake St. Clair and Detroit River Shorelines*. Environment Canada, Environmental Protection Branch Ontario Region, Downsview, Ontario, 1994, 79 pages.

31. Southeast Michigan includes the counties of St. Clair, Macomb, Oakland, Livingston, Washtenaw, Wayne, and Monroe. Lapeer and Sanilac Counties are added here for informational purposes but are not included in the employment statistics provided in Table IIA3-1. County profiles accessed at http://medc.michigan.org/miinfo/places

32. A Decade of Prosperity in Southeast Michigan: Comparing 1990 and 200 Census Data, Southeast Michigan Council of Governments, Detroit, Michigan, 2002.

33. *Ibid.*

34. Southwest Ontario includes the Counties of Oxford, Elgin, Middlesex, Lambton, Essex, Perth, Huron, Bruce, Grey and the Chatham-Kent Division.

35. City of Windsor, Planning Department, Office of the City Planner, Official Plan, 2004. Web Site: www.citywindsor.ca/000423.asp

36. Ontario Economic Outlook and Fiscal Review, Canadian Ministry of Finance, Toronto, Ontario, 2002.

37. *Ibid.*

38. "Primary Industries" includes Agriculture, however, the referring document does not individually break out figures for Farming, Forestry, or Fishing in its tables.

39. Coastal Management Program Section 309 Enhancement Grants Assessment/Strategy, Michigan Department of Environmental Quality, Lansing, Michigan, 2001.

40. Michigan Public Acts 263 (amending Township Planning Act 168 of 1959), 264 (amending Municipal Planning Act 285 of 1931) and 265 (amending County Planning Act of 1945) of 2001 became effective in January 2002.

41. Michigan Public Acts 177,178,and179 of 2001.

42. Revised Statutes of Ontario, Chapter P 13) 1990--RSO c.p.13. www.e-laws.gov.on.ca

43. Bill 26: Proposed Change to Implementation Standard for PPS Policies, June, 2004.

44. NOAA, 1995 - 2000 *op. cit.*

45. NOAA, 1995 - 2000 *op. cit.*

46. Southeast Michigan Council of Governments, 2003. Land Use Change in Southeast Michigan: Causes and Consequences.

47. Ontario Ministry of Municipal Affairs and Housing, Western Ontario Smart Growth Panel, Final Report, Fall, 2003, Toronto, ON. Web site: www.mah.gov.on.ca/userfiles/HTML/nts_1_5887_1.html

48. The Lake St. Clair Canadian Watershed Technical Report: An examination of current conditions, December 30, 2003 Draft Report for review dated 2-6-04.

49. Ontario Ministry of Municipal Affairs and Housing, Western Ontario Smart Growth Panel, Final Report, Fall, 2003, Toronto, ON. Web site: www.mah.gov.on.ca/userfiles/HTML/nts_1_5887_1.html

50. Ontario Ministry of Finance, Update to Ontario Population Projections 2001-2028. August 2002. Web site: http://www.gov.on.ca/FIN/english/demographics/demog02et1.htm

51. County of Essex. County of Essex Official Plan Discussion Paper No. 1 December 1998. County of Essex, December 1998.

52. The Lake St. Clair Canadian Watershed Technical Report: An examination of current conditions, December 30, 2003 Draft Report for review dated 2-6-04.

53. Ontario Ministry of Finance, Windsor-Essex: In Profile, Provincial Planning and Environmental Services Branch, Ministry of Municipal Affairs and Housing, 2003. Web site: www.mah.gov.on.ca/userfiles/HTML/nts_1_12605_1.html

54. The Lake St. Clair Canadian Watershed Technical Report: An examination of current conditions, December 30, 2003 Draft Report for review dated 2-6-04.

55. County of Essex. County of Essex Official Plan Discussion Paper No. 2, February 1999. County of Essex 1999.

56. *Ibid.*

57. Essex Region Conservation Authority. 1999 Essex Biodiversity Conservation Strategy. Essex Region Conservation Authority, 1999.

58. *Ibid.*

59. Essex Region Conservation Authority, 360 Fairview Avenue West, Essex ON, 2002. Web site: www.erca.org/home.htm

60. City of Windsor, Planning Department, Office of the City Planner, Official Plan, 2004. Web Site: www.citywindsor.ca/000423.asp

61. *Ibid.*

62. County Planning Department, The Corporation of the County of Lambton, Wyoming, Ontario, CA, Official Plan, 2004
Web Site: www.lambtononline.ca/official_plan2

63. County Planning Department, The Corporation of the County of Lambton, Wyoming, Ontario, CA, Official Plan, 2004
Web Site: www.lambtononline.ca/official_plan2

64. Ontario Ministry of Finance, Finance Projections 1999-2028, Toronto, Ontario, Canada 2000.

65. Office of Planning, New Official Plan Draft, September, 2003, Municipality of Chatham-Kent, Chatham, Ontario.

66. *Ibid*.

67. *Ibid.*

Section III. Physical Characterization

III. A. Climate

The location of Lake St. Clair minimizes the influence of Great Lakes weather patterns associated with prevailing westerly winds except for a noticeable increase in cloudiness during the late fall and early winter months. Northerly winds blowing off Lake Huron often produce a similar "lake" effect of cloudy skies. Local Lake St. Clair breezes modify temperatures during the summer months. Diminished wind speeds or winds that do not traverse large unfrozen lakes often produce clearing skies and the colder temperatures expected at mid-continent locations.

HIGHLIGHT

The Lake St. Clair region seldom experiences prolonged periods of hot, humid weather in the summer or extreme cold during the winter.

Because the day-to-day weather is controlled by the movement of pressure systems across the continent, the Lake St. Clair region seldom experiences prolonged periods of hot, humid weather in the summer or extreme cold during the winter. The prevailing wind is southwesterly, averaging 10 mph. The strongest one-minute wind speed, 95 mph, was recorded in June 1890. The average 1:00 p.m. relative humidity varies from 53 percent for May and July to 71 percent for December, and averages 60 percent annually. The average percent possible sunshine varies from 29 percent for December to 69 percent for July, and averages 53 percent annually.

Summers are dominated by moderately warm temperatures. Between 1951 and 1980 an average of 8 days exceeded the 90° F (32° C) mark. During the same period, on average, 1 day was 100° F (38° C) or higher. During this period, the lake influence was reflected in the minimum temperatures; an average of 134 days was 32° F (0° C) or lower, an average of 4 days was 0° F (-18° C) or lower, and only 5 years stayed above 0° F (-18° C). The highest average monthly maximum temperature of 89.0° F (32° C) was recorded July 1955 and the lowest average monthly minimum temperature of 6.5° F (-14° C) was recorded January 1977.

Temperature extremes (as recorded at Selfridge Air National Guard Base):

- Maximum = 106° F (41° C), recorded July 5, 1911
- Minimum = -24° F (-31° C), recorded February 10, 1912
- Warmest monthly mean = 78.7° F (25.9° C), recorded July 1955
- Coldest monthly mean = 13.2° F (-10.4° C), recorded January 1977

Heating and cooling degree-day data are used as an index of the heating and cooling requirements for buildings which are proportional to the number of degree-days. Heating degree-days for a single day are obtained by subtracting the mean temperature from 65° F (18° C) when the mean temperature is below 65° F (18° C). Cooling degree-days for a single day are obtained by subtracting 65° F (18° C) from the mean temperature when the mean temperature is above 65° F (18° C). Each are then summed to yield monthly totals.

Again looking at the 1951-80 period, the average date of the last freezing temperature in the spring was April 27, while the average date of the first freezing temperature in the fall was October 19. The freeze-free period, or growing season, averaged 174 days annually.

Precipitation was well distributed throughout the year with the crop season, April-September, receiving an average of 16.14 inches or 57 percent of the average annual total for the 1951-80 period. During this same period the average

wettest month was June with 3.04 inches, while the average driest month was February with 1.53 inches. Average precipitation for the project area is 33.97 inches (86.28 cm).

Precipitation extremes (as recorded at Selfridge Air National Guard Base):

Greatest precipitation in a single day = 4.78 inches, recorded June 26, 1968
Greatest precipitation in a single month = 9.22 inches, recorded July 1976
Least precipitation in a single month = 0.00 inches, recorded December 1900

Summer precipitation comes mainly in the form of afternoon showers and thundershowers. Annually, thunderstorms occur on an average of 35 days. Lake St. Clair is located on the northeast fringe of the tornado belt. The lower frequency of tornadoes occurring in Southeast Michigan and Southwest Ontario may be the result of the colder waters of Lake Michigan during the spring and early summer months, a prime period of tornado activity. For instance, during 1950-87, Michigan averaged 15 tornadoes each year. During this same period, 14 tornadoes occurred within Macomb County. The 1950-51 through 1979-80 average seasonal snowfall was 34.4 inches. During this period, 50 days per season averaged 1 inch or more of snow on the ground, but varied greatly from season to season.

FACT

Lake St. Clair is located on the northeast fringe of the tornado belt. The lower frequency of tornadoes occurring in Southeast Michigan and Southwest Ontario may be the result of the colder waters of Lake Michigan during the spring and early summer months, a prime period of tornado activity.

Evaporation data from the Class "A" pan[1] were not available for Lake St. Clair, but should be similar to those observed at Dearborn, Michigan where during the 1953-1980 time frame the pan evaporation for May through October exceeded the average precipitation by 86 percent. Therefore, soil moisture replenishment during the fall and winter months plays an important role in the success of agriculture for this area. While drought occurs periodically, the Palmer Drought Index indicated drought conditions reached extreme severity only 2 percent of the time.[2]

Snowfall extremes (as recorded at Selfridge Air National Guard Base):

Greatest snowfall in a single day = 13.7 inches, recorded March 27, 1934
Greatest snowfall in a single month = 29.6 inches, recorded January 1978
Greatest seasonal total = 77.5 inches, recorded during 1925-26
Smallest seasonal snowfall = 11.2 inches, recorded during 1982-83 season
Greatest snow depth = 19 inches, recorded February 5, 1904

III. B. Geology/Geography

During the Pleistocene epoch, continental glaciers repeatedly advanced and retreated over the present day Great Lakes region. Sand, silt, clay and rock were deposited in various mixtures and forms as the glaciers receded. These deposits are collectively referred to as glacial drift and created geomorphic features such as moraines, flat till plains, till drumlins,

HIGHLIGHT

Glacial lakes once covered the entire project area, as well as present-day Lake Erie, and parts of Ontario, Ohio and southeast Michigan. Fine-grained clays and silts deposited in glacial lakes are exposed today as lakeplain, with old beach ridges interspersed within the clayey, silty soils.

and eskers. Areas having substantial deposits of well sorted sands and gravels (eskers, kames, and outwash plains) are usually significant aquifers.[3]

As the glaciers began to retreat, meltwater collected in large lakes between the ice front and the previously deposited end moraines. As mentioned earlier, glacial lakes once covered the entire project area, as well as present-day Lake Erie, and parts of Ontario, Ohio and southeast Michigan[4]. Fine-grained clays and silts deposited in glacial lakes are exposed today as lakeplain, with old beach ridges interspersed within the clayey, silty soils. Moraines within the project area were deposited in water and subsequently eroded, making them difficult to identify today[5].

About 4,000 years ago, the precursor to today's Great Lakes, or the "Nipissing" Great Lakes, began to wane due to crustal rebound as the glaciers retreated, forcing the full discharge of the upper Great Lakes through the St. Clair and Chicago Rivers. The Chicago outlet, having a limestone sill[6], resisted downward cutting. The St. Clair outlet, channeled in unconsolidated glacial drift, yielded to steady erosion. When the upper lakes' (e.g., Lakes Superior, Michigan and Huron) surface dropped below the level of the Chicago River, the St. Clair River became the only outlet. As these lake levels continued to drop, a series of clay lake plains were exposed. The tributaries flowing into Lake St. Clair deposited sediments along valley floors to create floodplains. Concurrently, deposition in Lake St. Clair created the St. Clair Delta due to the shallowness on the lake and the abundance of sediments. No other significant deltaic formations occur in the Great Lakes.[7]

Michigan

Lake St. Clair and the majority of its watershed is located within the Maumee Lake Plain landform. The Maumee Lake Plain, a broad, flat plain, is bounded on the west by the Defiance Moraine and extends south into northern Ohio. The northern third of the lake plain, where the project area lies, is bisected by drainage-ways, narrow beach ridges and several water-lain moraines, which collectively form a mosaic of slight rises and depressions. See Figure III B - 1 for a generalized view of the quaternary geology in Michigan bordering Lake St. Clair[8].

The Clinton River, located just north of Detroit, flows 80 miles (128 km) from its headwaters to Lake St. Clair near the city of Mt. Clemens. The river drains 760 square miles (1,968 km2) of southeastern Michigan, including portions of Oakland and Macomb Counties and small areas of St. Clair and Lapeer Counties. Its entire watershed is considered an Area of Concern. About half of the river's flow is treated wastewater

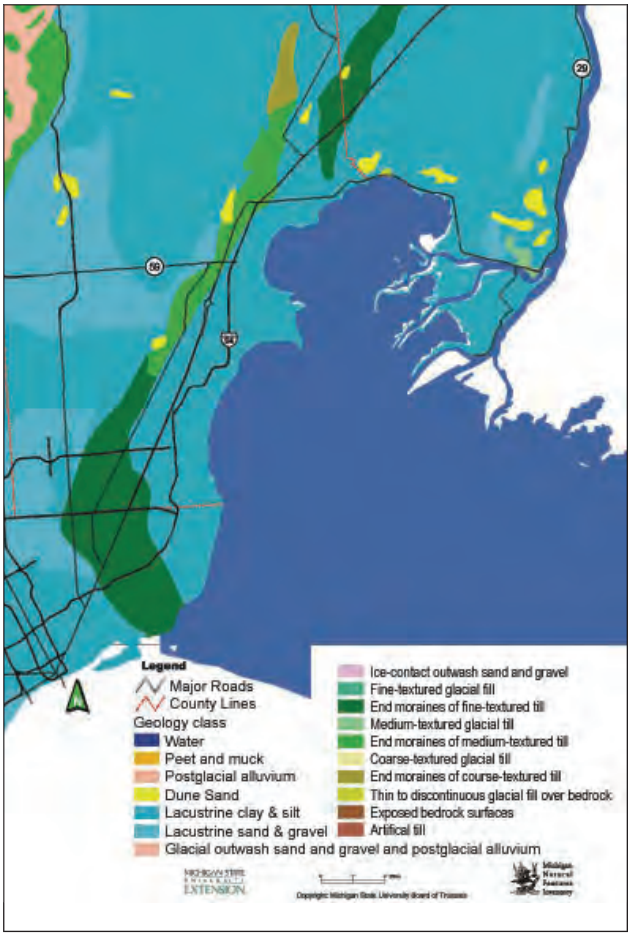


Figure III B - 1
Southeast Michigan quartnernary geology

from six municipal wastewater treatment plants. Land use on the north branch of the river is agricultural. The main industries in the area are automotive-related[9].

Ontario

Lake St. Clair is located within the St. Clair Clay Plain physiographic region, which encompasses the majority of the counties of Lambton, Kent, and Essex. The St. Clair Clay Plain has little topographic relief. The St. Clair Clay Plain is subdivided into four regions: the Essex Clay Plain, the Lambton Clay Plain, the Chatham Flats, and the St. Clair Delta. A major tributary to Lake St. Clair, the Thames River drains a 350,000 hectare (864,870 acre) watershed of southern Ontario lands, mostly in agricultural use. As the river approaches St. Clair, it crosses flat clay plains; between Chatham and the lake, the river drops less than 0.01m/km. The shallow Thames River channel has been extensively dyked to control the frequent spring flood waters, and little natural wetland habitat remains along the river flood plain. The lakeshore marshes lie on stratified clays combined with a series of sandy beach ridges formed long ago by lake wave action. There is an overlying deposit of organic materials from decayed marsh vegetation. The clay plains are among the most fertile in Canada. The rich soils once supported tall grass prairies and now produce fertile marshes or high yields of agricultural crops.[10]

HIGHLIGHT

The Lake St. Clair watershed is comprised of the contributing waters of Anchor Bay, Clinton River, Belle River, Black River, and Pine River on the Michigan side and the Thames River, Sydenham River and Belle River on the Ontario side, as well as direct drainage.

III. C. Hydrology

The Lake St. Clair watershed is comprised of the contributing waters of Anchor Bay, the Clinton, Belle, Black and Pine Rivers on the Michigan side and the Thames, Sydenham and Belle Rivers on the Ontario side, as well as direct drainage. The Great Lakes waters of Superior, Michigan, and Huron feed Lake St. Clair through the St. Clair River and exit the lake through the Detroit River to Lake Erie. The Lake St. Clair watershed encompasses approximately 3,927,175 acres (1,589,270 hectares) in Michigan and Ontario. Lake St. Clair itself has an area of 430 square miles (1,115 square kilometers) with a shoreline length of 169 miles (272 kilometers)[11]. Its average depth is 12 feet (3.7 meters) with a maximum natural depth of 21 feet (6.4 meters). In 1855 a commercial navigation channel was dredged through the lake from the St. Clair Cutoff Channel (between Seaway Island and Bassett Island) to the Detroit River. The navigational channel is now maintained to a depth of 27.2 feet (8.3 meters). The average retention time for water in Lake St. Clair is nine days.[12]

Due to the shallow depth of Lake St. Clair, water dynamics are greatly affected by wind, lake levels, and stratification. "Wind set-up", is a phenomena associated with a major lake storm whereby a local rise in water is caused by winds pushing water to one side of a lake. Another extreme form of oscillation, known as seiche, occurs with rapid changes in winds and barometric pressure.[13]

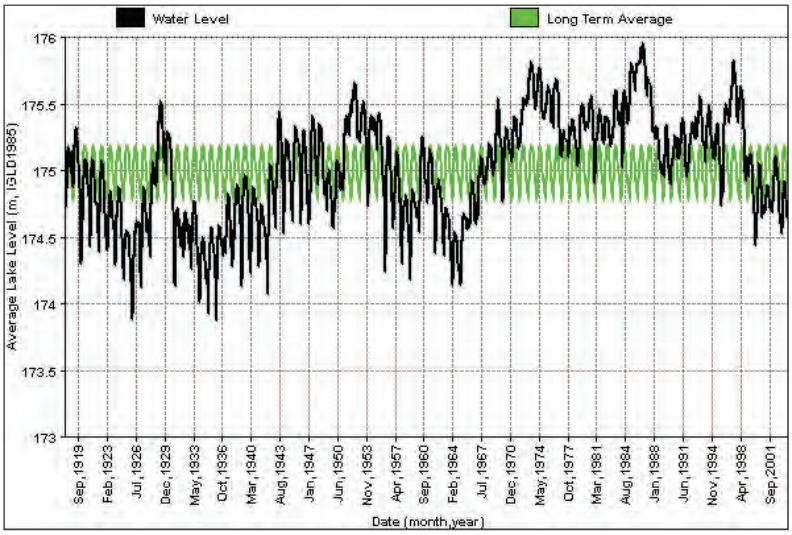


Figure III C - 1
Lake St. Clair historic water levels

HIGHLIGHT

Water level fluctuations are an important factor in Great Lakes coastal wetlands development. Lake St. Clair's gently sloping marshes and lakeplain experience dramatic changes as a result of relatively small fluctuations, which create diversity among plant and animal communities that rely upon the highly changeable wetland environment.

Stratification, or layering, of water in the lake is due to density changes caused by shifts in temperature. The density of water increases as temperature decreases. In the late fall surface waters cool, becoming denser, and descend, displacing deep waters and cause a mixing or turnover of the entire lake. The process may be repeated in reverse during the warming of the spring. Lake stratification as it warms in summer can also prevent the dispersion of effluents from tributaries causing increased concentration of pollutants near the shore.

Lake levels fluctuate significantly as a consequence of climate variability upstream in the upper Great Lakes and local short term weather events. Long term changes in water levels on Lake St. Clair are usually the result of precipitation. Temperature, cloud cover and winter ice cover that drive evaporation are also factors. Short term changes in water levels on Lake St. Clair also occur within a few days of heavy rains in the Thames and Clinton River watersheds or when ice dams appear in the St. Clair and Detroit Rivers. Water levels have declined throughout the Great Lakes and Lake St. Clair over the last five years. While the declining lake levels have alarmed some recreational boaters and others dependant upon access to nearshore infrastructure, current levels are not inconsistent with historic lake level fluctuations. On average, Lake St. Clair's water levels vary about 1.6 feet (0.5 meters) annually, with low levels typically occurring in February and high levels occurring in July. Figure III C - 1 shows water levels in Lake St. Clair from 1918 to 2002 rising and falling over a range of 6.6 feet (2 meters)[14].

Water level fluctuations are an important factor in Great Lakes coastal wetlands development. Lake St. Clair's gently sloping marshes and lakeplain experience dramatic changes as a result of relatively small fluctuations, which create diversity among plant and animal communities that rely upon the highly changeable wetland environment.

Modeling has shown that circulation patterns for Lake St. Clair fall into three large regions. Waters on the western side (Michigan) are fed primarily by the North and Middle Channels of the St. Clair River Delta and the Clinton River, which form a spiral clockwise flow pattern bounded by the western shoreline and the navigational channel. Water entering the lake through the South and Cutoff Channels of the St. Clair River Delta remain in or adjacent to the navigational channel to the Detroit River. Flows on the eastern side (Ontario) are fed by the channels in and around Walpole Island First Nation and the Thames River. These flows form an eastern counterclockwise gyre. Because of the fast velocities and substantial water temperature difference for flows within the maintained commercial navigational channel, mixing between the western and eastern regions is infrequent.[15]

III. D. Land Cover

Generally, the forests, tall grass prairies and coastal wetlands of the project area have given way to urban, residential and farming lands. However, on the unceded lands of Walpole Island First Nation in the delta of the St. Clair River, remnant plots of tall grass prairie, savanna and extensive coastal wetlands remain, though modification through diking and draining have still occurred. For a more detailed discussion on the existing habitat and land cover types within the project area, please read Section IV. Major Ecosystem and Habitat Types of Lake St. Clair.

The Lake St. Clair area has experienced a long history of human settlement due to its rich natural resources and key location along the Great lakes trade routes. The most unique aspect of Lake St. Clair's historical land cover were the vast coastal marshes that spread across the mouth of St. Clair River in the mid 1800's. What made these marshes particularly

unique was not just their sheer size, but the fact that they were located on what is considered today to be the largest freshwater delta in the world. In much of the delta these marshes graded into lakeplain prairie. Sizable marshes were also located at the mouth of the Clinton River, and further south in what is now Grosse Pointe. Although presettlement vegetation maps are presently available only for Michigan, Figure IIID-1 gives a sense of what natural communities were present on both sides of the lake.

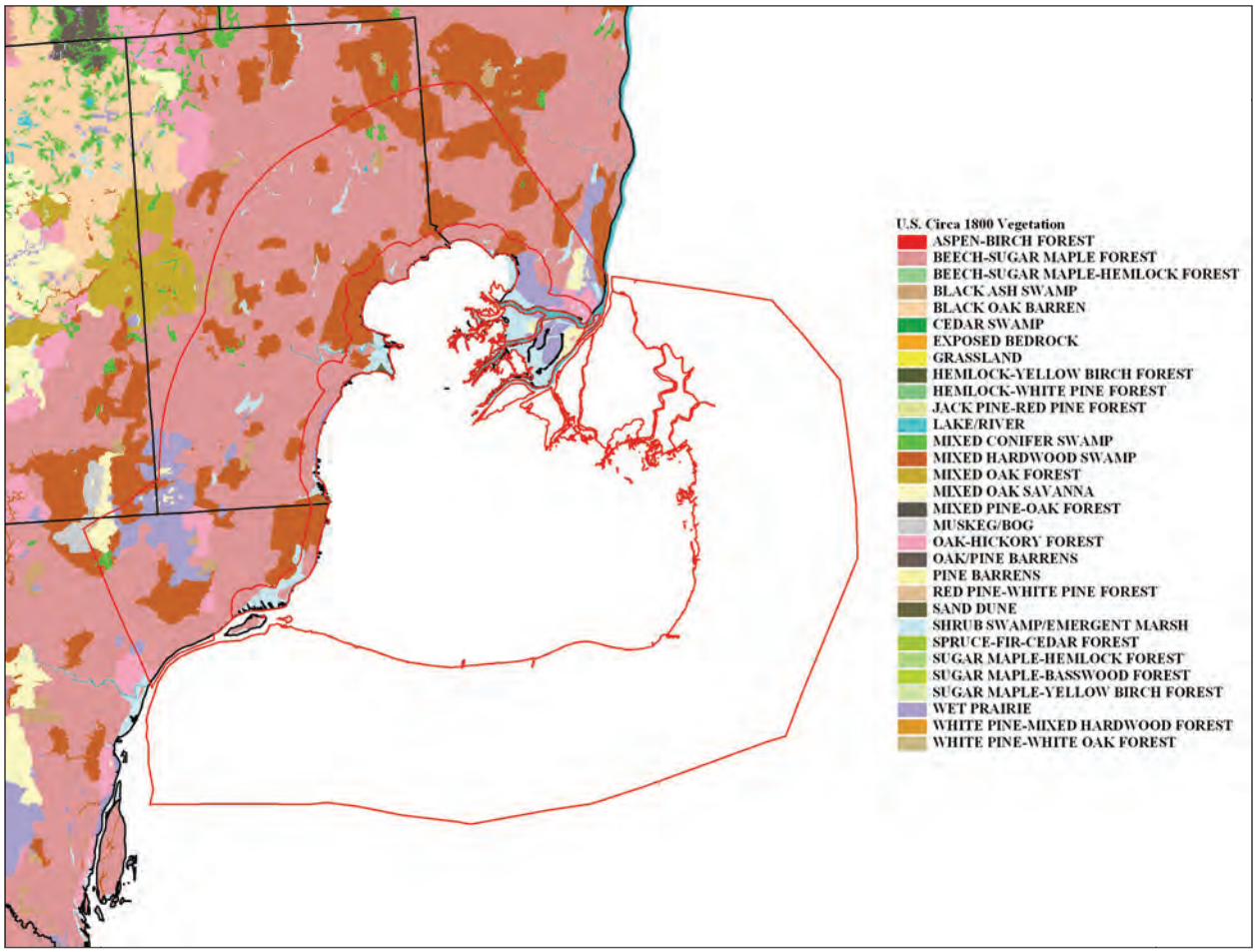


Figure III D - 1

Since the mid 1800's, this area has undergone a tremendous transformation from nomadic Native American tribes to intensive urbanization and agricultural operations. As a result, much of the abundant natural resources that originally attracted Native Americans and European settlers to this area have suffered serious declines or have been lost.

HIGHLIGHT

Ontario is dominated by agricultural lands whereas Michigan is represented by a more diverse grouping of high and low intensity development, agricultural land, grassland and deciduous forest.

The greatest losses in the study area were the loss of lakeplain prairie (98.2% loss) and lakeplain oak openings (92.7% loss), both of which are considered to be globally imperiled communities. In addition, there was also a large decrease in all forest types, including mesic southern forest, dry mesic southern forest, southern floodplain forest, and southern swamp. Although there was only a 30% loss of Great Lakes marsh (overall), most of the remaining marsh has been dyked and hydrologically disconnected from Lake St. Clair. If only undiked Great Lakes marsh is considered, probably less than 10% of the original acreage of Great Lakes marsh

remains in the Lake St. Clair system. Changes in acreage of important natural community types between 1800 and 2000 are shown in Figures IIID - 2 and IIID - 3.

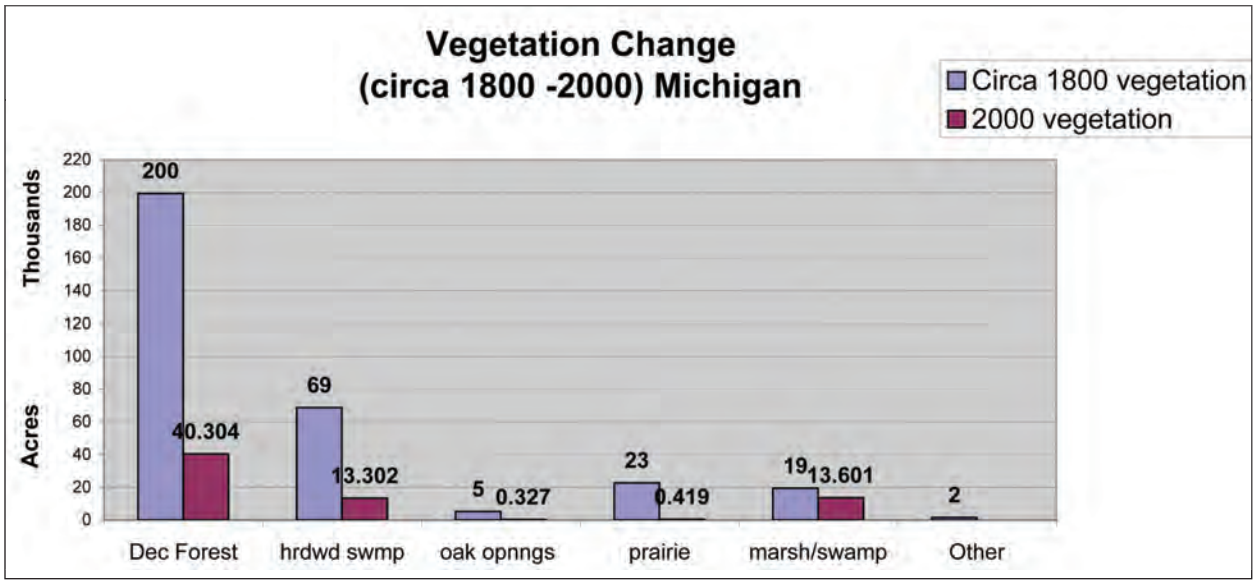


Figure III D - 2
Source: Michigan Natural Features Inventory

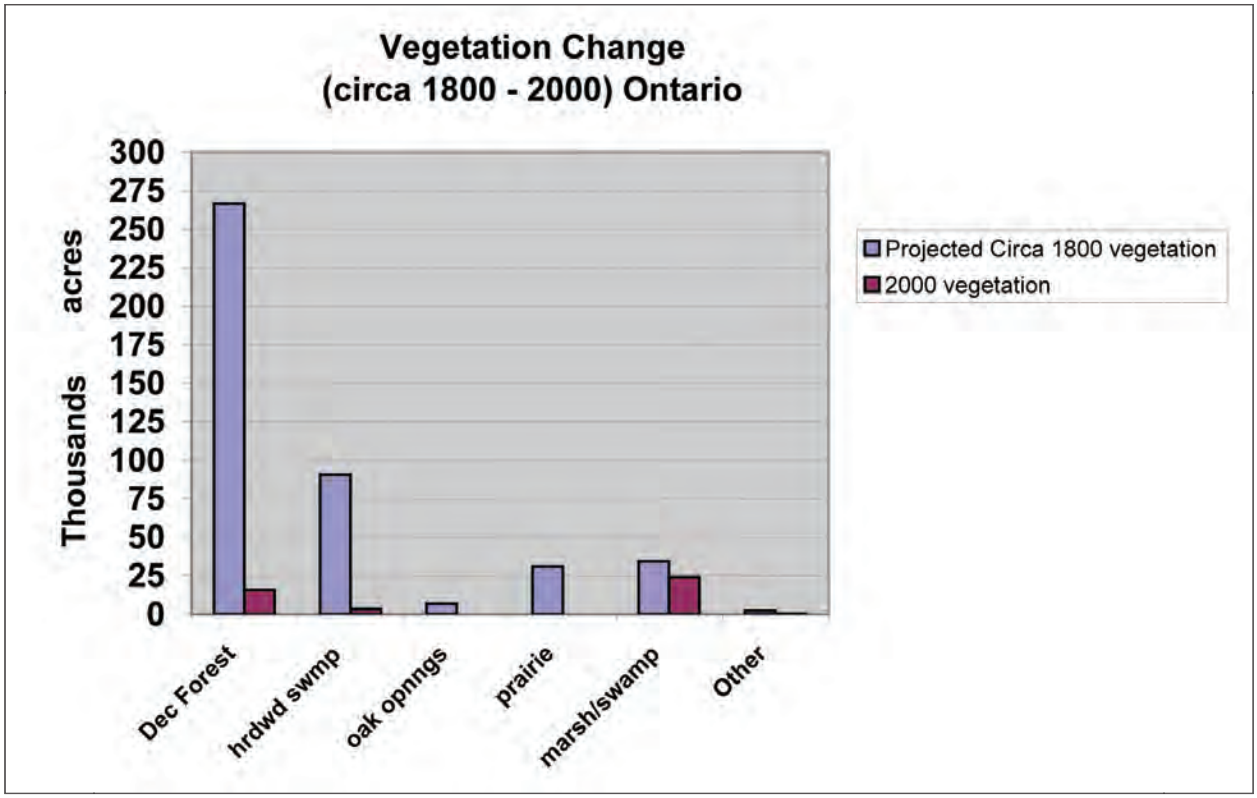


Figure III D - 3
Source: Michigan Natural Features Inventory

In assessing present-day land cover, the tool used to identify basic land cover types within the project area is NOAA's Coastal Change Analysis Program (C-CAP). C-CAP was developed to distribute and apply land cover and change data

Table III D - 1

1995 - Land Cover Types	Acres
High-Intensity Developed	4,618
Low-Intensity Developed	123,112
Cultivated Land	386,037
Grassland	54,517
Deciduous Forest	54,254
Evergreen Forest	5,967
Mixed Forest	2,721
Scrub/Shrub	3,885
Palustrine Forested Wetland	17,113
Palustrine Scrub/Shrub Wetland	11,550
Palustrine Emergent Wetland	20,497
Unconsolidated Shore	742
Bare Land	1,723
Water	44,002
Palustrine Aquatic Bed	2,795

for the U.S. coast line. These data sets can be used to assess urban growth, determine changes to natural resources, and develop trend analyses. C-CAP data is 30-meter pixel resolution data derived from Landsat 7 satellite imagery. C-CAP, the USGS National Land Cover Dataset (NLCD) and the Integrated Forest Monitoring, Assessment and Prescription (IFMAP) products are similar For more detailed information on C-CAP, please refer to Section VII. A. C-CAP Products and Application.

Using the analysis from the 1995 and 2000 Coastal Change Analysis Products (C-CAP) from the State of Michigan and the 10-mile buffer from the Province of Ontario surrounding Lake St. Clair, some basic landscape inventories and quantities of land cover change can be computed. Following are a series of charts and tables that illustrate the use of C-CAP within the project area. Table IIID - 1 shows the acreage of the various land cover types within the project area in 1995, as identified in C-CAP images.

In 1995, 49.8% of the project area was identified as cultivated land, the next dominate land cover type was low density developed at 15.9%. Graphically, the distribution of land cover types by percentage is illustrated in the pie chart in Figure IIID - 4.

When similar land cover types listed above are grouped as indicated in Table IIID - 2, agricultural occupies 56.8% of the landscape, forest 8.7%, wetland 6.7%, urban 22.1% and other 5.8%.

For the project area in 2000, the acreage of the various land cover types identified in C-CAP images is shown in Table IIID - 3.

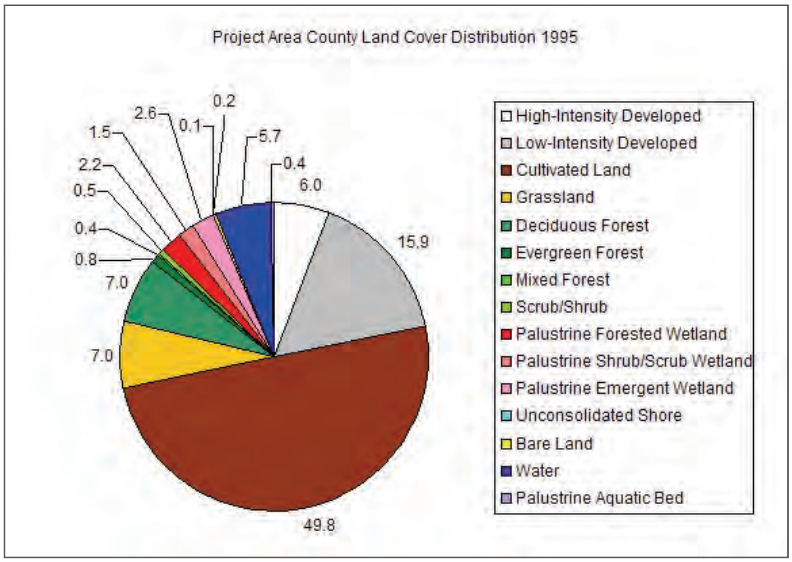


Figure III D - 4

Table III D - 2

Group	Land Covers Included
Wetland	Forested Wetland, Scrub/Shrub Wetland, Emergent Wetland, Aquatic Bed
Forest	Deciduous Forest, Evergreen Forest, Mixed Forest, Scrub/Shrub
Agriculture	Cultivated Land, Grassland
Urban	High-Intensity Developed, Low- Intensity Developed, Bare Land
Other	Water, Unconsolidated Shore

Table III D - 3

2000 - Land Cover Types	Acres
High-Intensity Developed	49,083
Low-Intensity Developed	124,996
Cultivated Land	377,987
Grassland	58,373
Deciduous Forest	52,911
Evergreen Forest	5,949
Mixed Forest	2,725
Scrub/Shrub	3,753
Palustrine Forested Wetland	16,868
Palustrine Scrub/Shrub Wetland	11,712
Palustrine Emergent Wetland	22,458
Unconsolidated Shore	747
Bare Land	2,163
Water	42,539
Palustrine Aquatic Bed	2,831

The pie chart in Figure IIID - 5 shows the percentage of each land cover type from the total acres in the project area. In 2000, 48.8% of the project area was identified as cultivated land, the next dominate land cover type was low density developed at 16.1%.

If the land cover types are divided as they were for the 1995 example, agricultural occupies 56.3% of the landscape, forest 8.5%, wetland 7%, urban 22.7% and other 5.6%.

An analysis of the change over the five years shows that 14,314 acres changed land cover designation. The land cover types that experienced the largest increases were grassland (35.5%), high density developed (20.4%), and emergent wetland (14.2%), as indicated in Figure IIID - 6.

The land cover types that experienced the largest losses were cultivated land (57.6%), deciduous forest (11.5%) and bare land (11.1%), as indicated in Figure IIID - 7.

Over 400 possible land cover changes were possible, making a meaningful graphical display of the information difficult. The previous two figures show only the most significant increases and decreases in land cover types. Land cover changes can be depicted spatially in a general way by coloring all changes the same color. In Figure IIID - 8 below, all changes are displayed in red. The bulk of the 14,314 acres that changed were concentrated on the U.S. side of Lake St. Clair, north of Detroit.

Breaking down the change into the same groupings of agriculture, urban, forest, wetland, and other (water) as described above, Figure III D-9 shows four predominant changes in land use cover during the 5 year period.

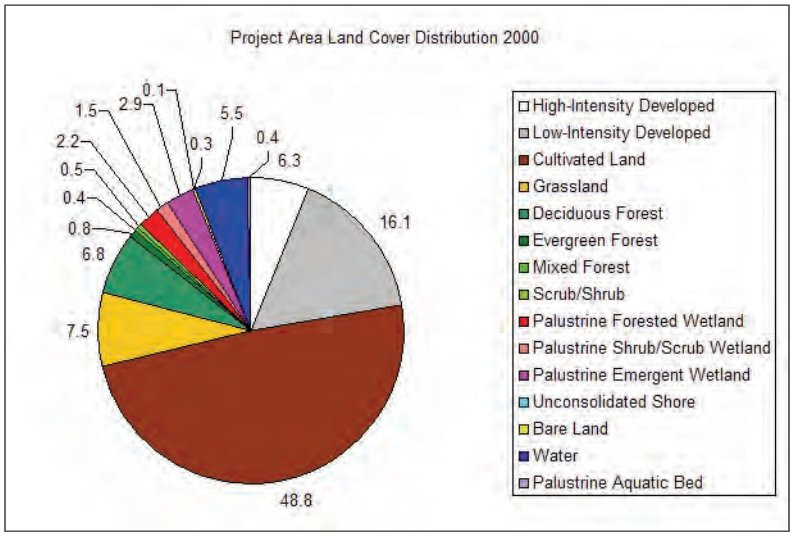


Figure III D - 5

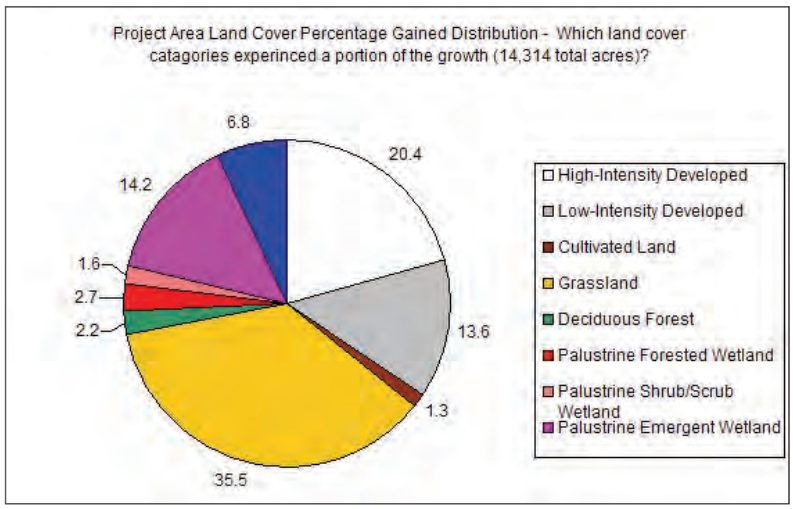


Figure III D - 6

Utilizing C-CAP, land cover was also analyzed separately for the Ontario and Michigan portions of the project area. What is immediately apparent from this exercise is the disparity between the relative proportion of different land cover types in Ontario and Michigan. Ontario is dominated by agricultural lands (77.57 percent - see Table III D - 4) whereas Michigan is represented by a more diverse grouping of high and low intensity development, agricultural land, grassland and deciduous forest (see Table III D - 5). The combined 43 percent high and low intensity development of the Michigan side of Lake St. Clair is representative of the northern expansion of the population from the Detroit Metropolitan area. See Section II. B. Population Growth/Migration for an in-depth discussion on population trends in the project area.

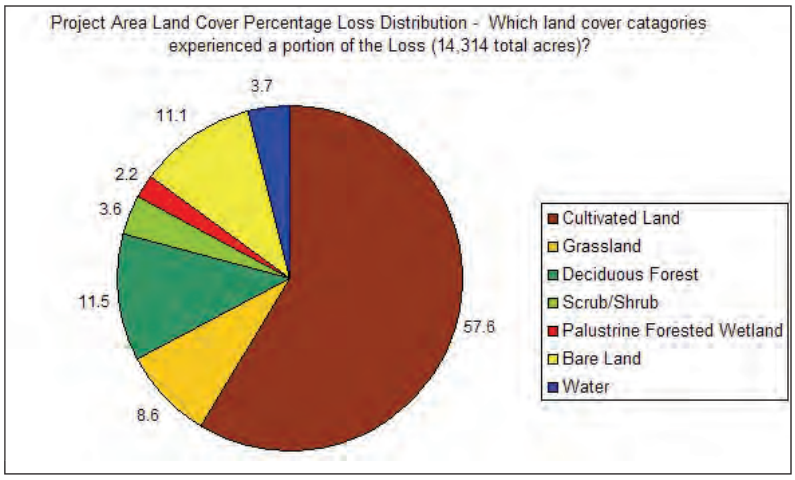


Figure III D - 7

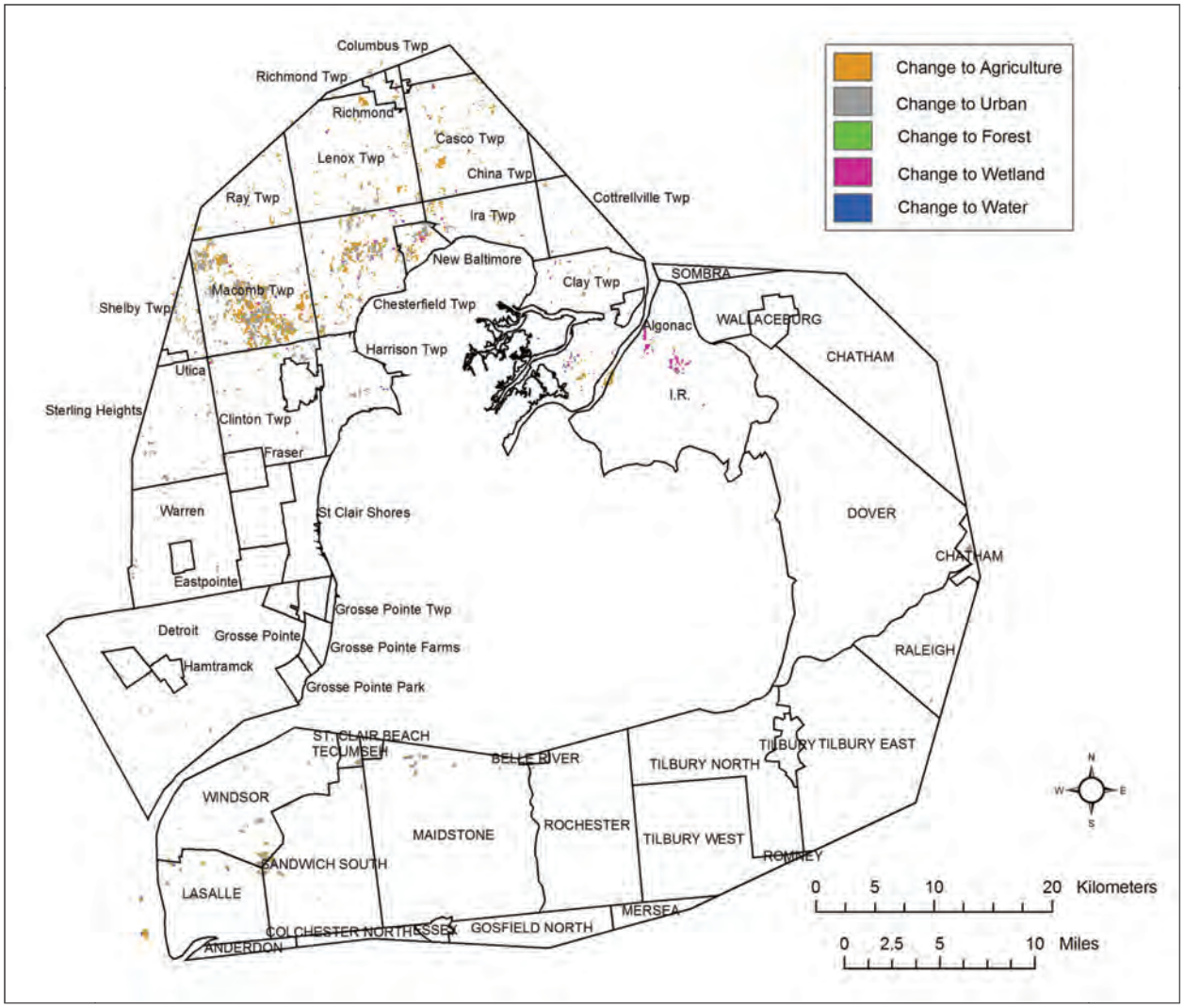


Figure III D - 9

Table III D - 4, Ontario Project Area Land Cover Distribution[16]

Class Name	Area - hectare	Area - acre	Percent
High Intensity Development	4,547	11,235	2.60%
Low Intensity Development	11,763	29,067	6.74%
Cultivated Land	135,441	334,683	77.57%
Grassland	6,338	15,660	3.63%
Deciduous Forest	6,444	15,925	3.69%
Evergreen Forest	0	0	0.00%
Mixed Forest	0	0	0.00%
Scrub/Shrub	0	0	0.00%
Palustrine Forested Wetland	1,379	3,408	0.79%
Palustrine Scrub/Shrub Wetland	0	0	0.00%
Palustrine Emergent Wetland	8,377	20,701	4.80%
Unconsolidated Shore	148	365	0.08%
Bare Land	157	389	0.09%
Palustrine Aquatic Bed	0	0	0.00%
TOTAL	**174,595**	**431,433**	**100.00%**

Table III D - 5, Michigan Project Area Land Cover Distribution[17]

Class Name	Area - hectare	Area - acre	Percent
High Intensity Development	15,705	38,807	12.32%
Low Intensity Development	38,977	96,315	30.59%
Cultivated Land	21,202	52,390	16.64%
Grassland	17,826	15,660	3.63%
Deciduous Forest	16,310	40,304	12.80%
Evergreen Forest	2,446	6,045	1.92%
Mixed Forest	1,130	2,792	0.89%
Scrub/Shrub	1,449	3,581	1.14%
Palustrine Forested Wetland	5,383	13,302	4.22%
Palustrine Scrub/Shrub Wetland	1,800	4,448	1.41%
Palustrine Emergent Wetland	8,377	20,701	4.80%
Unconsolidated Shore	248	612	0.19%
Bare Land	901	2,227	0.71%
Palustrine Aquatic Bed	1,188	2,937	0.93%
TOTAL	**127,433**	**314,893**	**100.00%**

Also, of particular note, is the scarcity of present-day wetlands and wetland complexes within the project area. Combined wetland categories for Ontario account for only 5 percent and in Michigan only 8 percent of the total project area which was once largely dominated by coastal and inland wetlands. Where the project area was once largely dominated by forest, wetland and prairies, it has since been logged, drained, farmed and now sub-divided for development on the Michigan side and mostly logged, drained and farmed on the Ontario side. Stresses on natural habitat and critical coastal habitat are apparent in Figure III D - 10, providing a general overview of existing land cover in the project area in 2000.

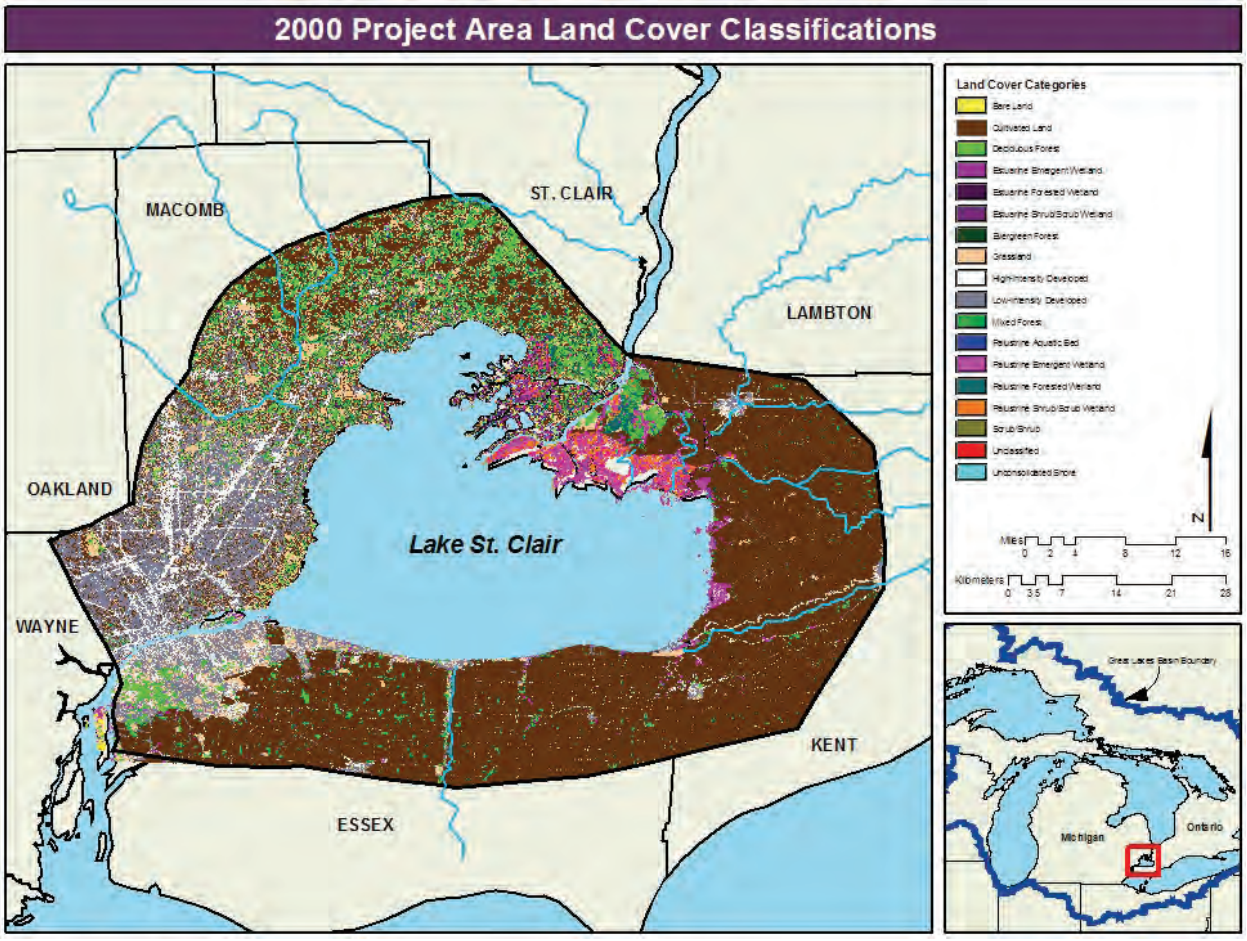


Figure III D - 10

III. E. Water Clarity and Lake St. Clair Substrate

Lake St Clair's water clarity varies at different locations. For the entire lake, the Secchi disk depth averages 1.8 meters, varying from as shallow as 3 meters in the nearshore areas of Anchor Bay to as deep as 5.1 meters in deep offshore waters (see Figure III E - 1). Anchor Bay's waters are the most turbid in Lake St Clair, particularly on the northern shoreline where the Secchi disk depth is less than a meter. However, in the near-shore areas surrounding the St Clair River Delta and in the St Clair River, the Secchi disks are visible at the bottom. The south end of the lakes Secchi disks depths vary between 0.3 and 2.0 meters, in waters 2.0 to 3.0 meters deep.[18]

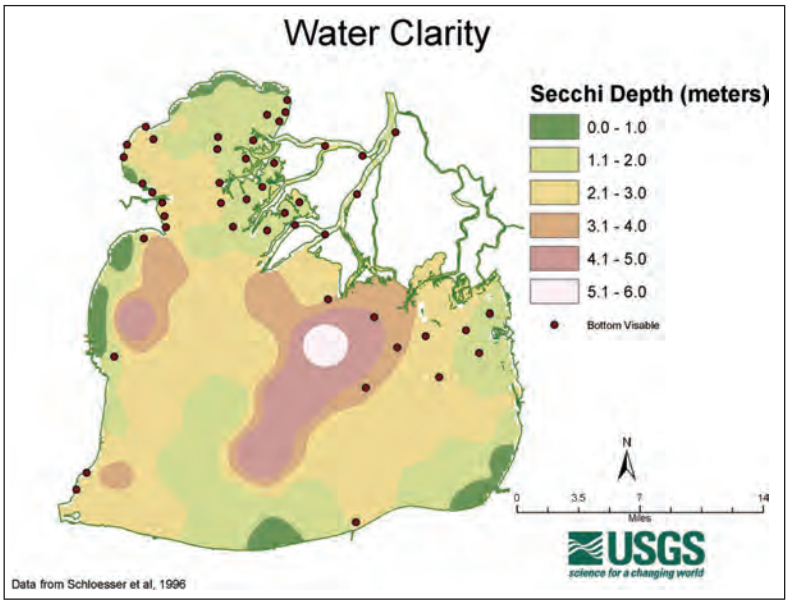


Figure III E - 1

Lake St Clair's substrates consist of clay, silt, sand and gravel. The sediments in the near-shore areas including the outlet of the St Clair river delta in Lake St Clair proper and the Detroit river mouth consist of 50% to 75% sand

with the remaining portion a mixture of silt and clay. The lake center's deposits are more then half silt plus a mixture of clay and sand. Areas near the delta, where the current slows at a quicker rate than other areas of the lake, have a greater silt and clay composition than sand. Gravel is rare, but can be found in very small portions near the St Clair River delta and at the head of the Detroit River (Figure III E - 2)[19]. Substrate types are important component of the habitat for benthic invertebrates, particularly *Hexagenia sp.*, an indicator of ecosystem health.[20]

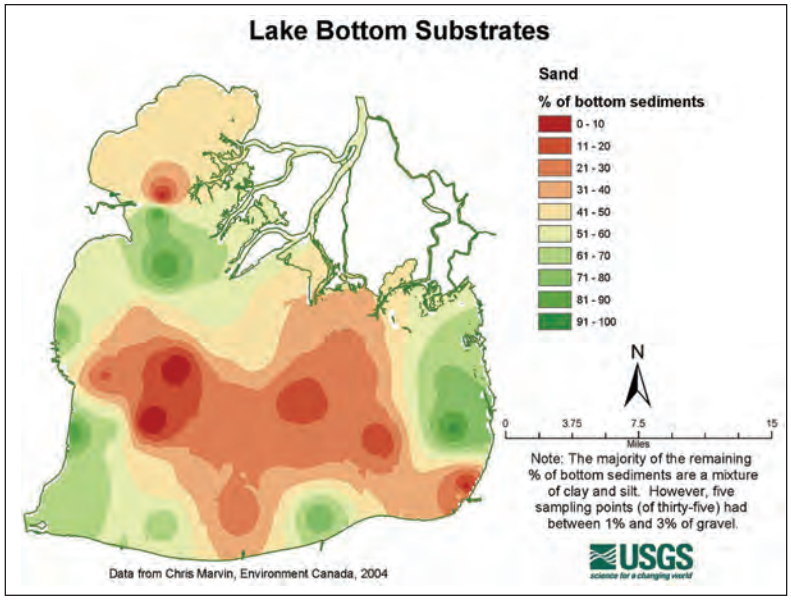


Figure III E - 2
Lake St. Clair Substrates

Section III Endnotes

1. This is a stainless steel pan for measuring daily evaporation. It is built to be compatible with all standard National Weather Service pan evaporation measurements. The stainless steel pan is normally installed on a wooden platform set on the ground in a grassy location. There are two commonly used procedures for making evaporation measurements. In both procedures, a 10" D x 47-1/2"ID stainless steel pan is used to hold the water. Since the amount of evaporation is a function of temperature, humidity, wind, and other conditions, in order to relate the evaporation to current or expected conditions, the maximum and minimum temperature of the water and the amount of air passage are normally recorded along with the evaporation. A "Class A" evaporation pan includes a drain plug and water level sensor.

2. Michigan Climatological Resources Program, Michigan Department of Agriculture's Climatologist's Office (East Lansing, Michigan).

3. The Great Lakes, An Environmental Atlas and Resource Book, U.S. Environmental Protection Agency (Chicago, Illinois) and Environment Canada (Toronto, Ontario), 1995.

4. Dorr, John A. & Eschman, Donald F., 1970. Geology of Michigan. The University of Michigan Press, Ann Arbor.

5. Appel, L, Craves, J., Smith, M., Weir, B. & Zawiskie, J. 2003 Draft. Explore: A Biodiversity Atlas of the Lake Huron to Lake Erie Corridor. Funded by USEPA, Great Lakes National Program Office and the Wildlife Habitat Council.

6. A submerged ridge at relatively shallow depth separating the basins of two bodies of water.

7. Farrand, William R., The Glacial Lakes Around Michigan, University of Michigan, Michigan Department of Environmental Quality - Geological Survey Division, Bulletin 4, 1988.

8. See note 1 above.

9. USEPA, 2004. Clinton River Area of Concern - Background (www.epa.gov/glnpo/aoc/clintriv.html) Accessed 3 November, 2004.

10. Eagles, P.F.J. and T.J. Beechey (eds.), Critical Unprotected Natural Areas in the Carolinian Life Zone of Canada. Final Report, Identification Subcommittee, Carolinian Canada. The Nature Conservancy of Canada, The Ontario Heritage Foundation and World Wildlife Fund (Canada), 1985.

11. Staff at the Great Lakes Commission utilized geographic information system data from the Ontario Ministry of Natural Resources - Land Information Office and Michigan Department of Information Technology - Center for Geographic Information to compile these figures.

12. Draft St. Clair River and Lake St. Clair Comprehensive Management Plan, U.S. Army Corps of Engineers, Detroit, Michigan, 2003.

13. Like water sloshing in a bathtub, seiches are tide-like rises and drops in Great Lakes coastal water levels caused by prolonged strong winds that push water toward one side of the lake, causing the water level to rise on the downwind side of the lake and to drop on the upwind side. When the wind stops, the water sloshes back and forth, with the nearshore water level rising and falling in decreasingly small amounts on both sides of the lake until it reaches equilibrium.

14. U.S. Army Corps of Engineers, Historic Great Lakes Water Levels, 1918 - 2002, www.lre.usace.army.mil/greatlakes/hh/greatlakeswaterlevels/historicdata/greatlakeshydrographs/

15. Holtschlag, David J., et. al., Visualization of a Drifting Buoy Deployment on Lake St. Clair within the Great Lakes Waterway from August 12-15, 2002, U.S. Geological Survey Open-File Report 02-482, Lansing, Michigan, 2002.

16. Coastal Change Analysis Program (C-CAP), National Oceanic and Atmospheric Administration, Coastal Services Center, Charleston, South Carolina, 2003.

17. Ibid.

18. Schloesser, D W, B A Manny, and T A Edsall. 1996. *Distribution and relative abundance of submerged aquatic plants in the Lake St Clair ecosystem*. Pp. 1-29. In: Edsall (ed) Aquatic plant management investigations of Lake St Clair, Michigan, 1995. Contract Completion Report for Detroit District Army Corps of Engineers. National Biological Service, Great Lakes Science Center, Ann Arbor, Michigan. 67pp.

19. Marvin, Chris. Research Scientist. Environment Canada. 867 Lakeshore Road. P.O. Box: 5050, Burlington, Ontario. Canada. (905) 319-6919 as of 3/16/04.

20. Schloesser, D.W., Edsall, T.A., Manny, B.A., Nichols, S.J. 1991. *Distribution of Hexagenia nymphs and visible oil in sediments of the Upper Great Lakes Connecting Channels*. Hydrobiologia. volume 219, page 250.

Section IV. Major Ecosystems and Habitat Types

Conserving and restoring habitat in rapidly urbanizing areas is both a challenge and a laudable endeavor but within the project area, the stakes are particularly high. The lands surrounding Lake St. Clair are home to several globally imperiled natural communities: lakeplain prairie, lakeplain oak openings and Great Lakes marsh. These communities are particularly vulnerable to the suppression of natural processes such as flooding, fire and water level fluctuation, which tend to be eliminated in developed lands. In both conserving and restoring these communities, restoring the underlying processes that shape them is as important as restoring the plant and animal species that live in them.

Ojibway Prairie Provincial Nature Reserve, Windsor, Ontario

Habitat is a word with a wide range of interpretations. A reference book defines habitat as "the type of environment in which an organism of a particular species is likely to be found[1]." A natural community is a distinct grouping of plants and animals that live together in a common habitat." Ecosystem, a broader term, encompasses "the total physical and biological environment in a given area with an emphasis on the relationships and connections among the various parts[2]." Technically, "habitat" is more species-focused, while "natural community" is focused on groups of different species associated with a particular habitat and "ecosystem" focuses on multiple natural communities and/or habitats and their interrelationship within a larger system. For purposes of this document, where the focus is on protecting and restoring communities of plants and animals within a given habitat and system, we will use the terms loosely and interchangeably.

The habitat types described in this plan integrate land cover data with field and other data on particular natural communities and species. Land cover is a term used frequently in interpreting satellite imagery which can show how wet or dry the landscape is, the type of vegetation growing on it and where there is no vegetation. Since many habitats are defined by the type of vegetation in that particular environment, land cover is an important indicator of habitat type.

FACT

Since many habitats are defined by the type of vegetation in that particular environment, land cover is an important indicator of habitat type.

Land cover data are derived from the National Oceanic and Atmospheric Administration's (NOAA) Coastal Change Analysis Program (C-CAP), which measures landcover data from satellite imagery with a 30-meter pixel resolution. The Coastal Land Cover Analysis Classification Scheme (*www.csc.noaa.gov/crs/lca/tech_cls.html*) used by C-CAP is used in this document as a framework within which the natural communities around Lake St. Clair are described. This classification scheme is based on the scheme found in the original *NOAA Coastal Change Analysis Program (C-CAP): Guidance for Regional Implementations*[3], which summarizes original C-CAP methods and procedures. The present C-CAP land cover classes reflect a consolidation based on implementation experience. Additionally, some C-CAP classes have been consolidated or reordered within this project to better reflect the land cover and habitats that characterize the Lake St. Clair region.

Specific terrestrial natural communities that are represented within the C-CAP land cover classes are named in accordance with *Michigan's Natural Communities: Draft List and Descriptions*[4] (*http://web4.msue.msu.edu/mnfi/data/MNFI_Natural_Communities.pdf*). Aquatic natural communities are named in accordance with terms defined in *Classification of Wetlands and Deepwater Habitats of the United States*[5]. Headings such as "Grasslands" and "Emergent Wetlands", for example are actual C-CAP land cover types, while subheadings such as "Lakeplain Oak Opening" and "Lacustrine Open Water" are specific natural communities.

IV. A. Upland/Terrestrial

Within the C-CAP classification system, uplands are lands lying above sea level where saturated soils and standing water are absent. In many ways, they are defined by what they are not, rather than by what they are. Uplands are not wetlands; they are not under water or seasonally flooded. They have non-hydric soils and are not moist enough for wetland plants to survive. The upland category includes developed lands, cultivated lands, grasslands, deciduous forest, evergreen forest, mixed forest and scrub/shrub[6]. Within the project area, C-CAP satellite data show over 675,000 acres (273,163 hectares) of uplands[7].

IV. A. 1. High intensity developed land

High intensity developed land consist of lands which have been altered significantly by people and are covered with structures and other impervious surface. Included in this category are cities, towns, villages, strip developments along highways, transportation, power, and communications facilities and areas such as those occupied by mills, shopping centers, industrial and commercial complexes, and institutions that may, in some instances, be isolated from urban areas[8]. High intensity developed lands consist of both heavily built up urban areas and buildings in more suburban settings with large areas of constructed surfaces. Vegetation, when present, covers less than 20 percent of the landscape. Cities clearly fall into this category, but airports, apartment complexes, factories and industrial complexes, malls, interstate highways and large agricultural facilities also appear here, although they occur in far more rural settings[9]. Within the project area, high intensity developed lands occupy almost 50,000 acres (20,234 hectares), or 6 percent of the total area, mostly occurring in the Michigan portion, in Detroit and its northern suburbs[10]. In the Canadian portion of the project area, high intensity developed lands are concentrated in the Windsor area[11].

FACT

High intensity developed lands consist of both heavily built up urban areas and buildings in more suburban settings with large areas of constructed surfaces.

From a habitat perspective, developed lands provide few opportunities for plants or animals and development tends to fragment existing habitat in the surrounding landscape. However, the inclusion of developed lands is important for documenting changes in land cover over time. Analysis of the C-CAP land cover data between 1995 and 2000 show a net increase of 4,800 acres (1,942.5 hectares) in total high and low intensity developed land within the project area and a commensurate re-

Detroit skyline

HIGHLIGHT

From a habitat perspective, developed lands provide few opportunities for plants or animals and development tends to fragment existing habitat in the surrounding landscape.

duction in all non-developed land categories[12]. While some of the non-developed lands lost may not be high quality habitat (e.g., agricultural lands) they can potentially be restored, a proposition that is much more difficult for lands that have been built or paved over. As such, loss of any undeveloped lands is a loss in actual or potentially valuable habitat. C-CAP data, which is collected at five-year intervals, will allow for land cover change analysis over longer time frames.

High intensity developed lands generally have little habitat value. In recent years, peregrine falcons, normally a cliff-nesting species, have successfully established a breeding population in the skyscrapers of downtown Detroit, but this is the exception rather than the rule[13]. Areas that do provide habitat can be particularly significant given the relative scarcity of alternatives in urbanized areas. Natural areas in urban parks that are connected to larger habitat patches outside urban areas can serve as critical ecological corridors. These areas, especially those with forests, ponds or wetlands, can be valuable places for migratory birds amidst a sea of concrete and rooftops.

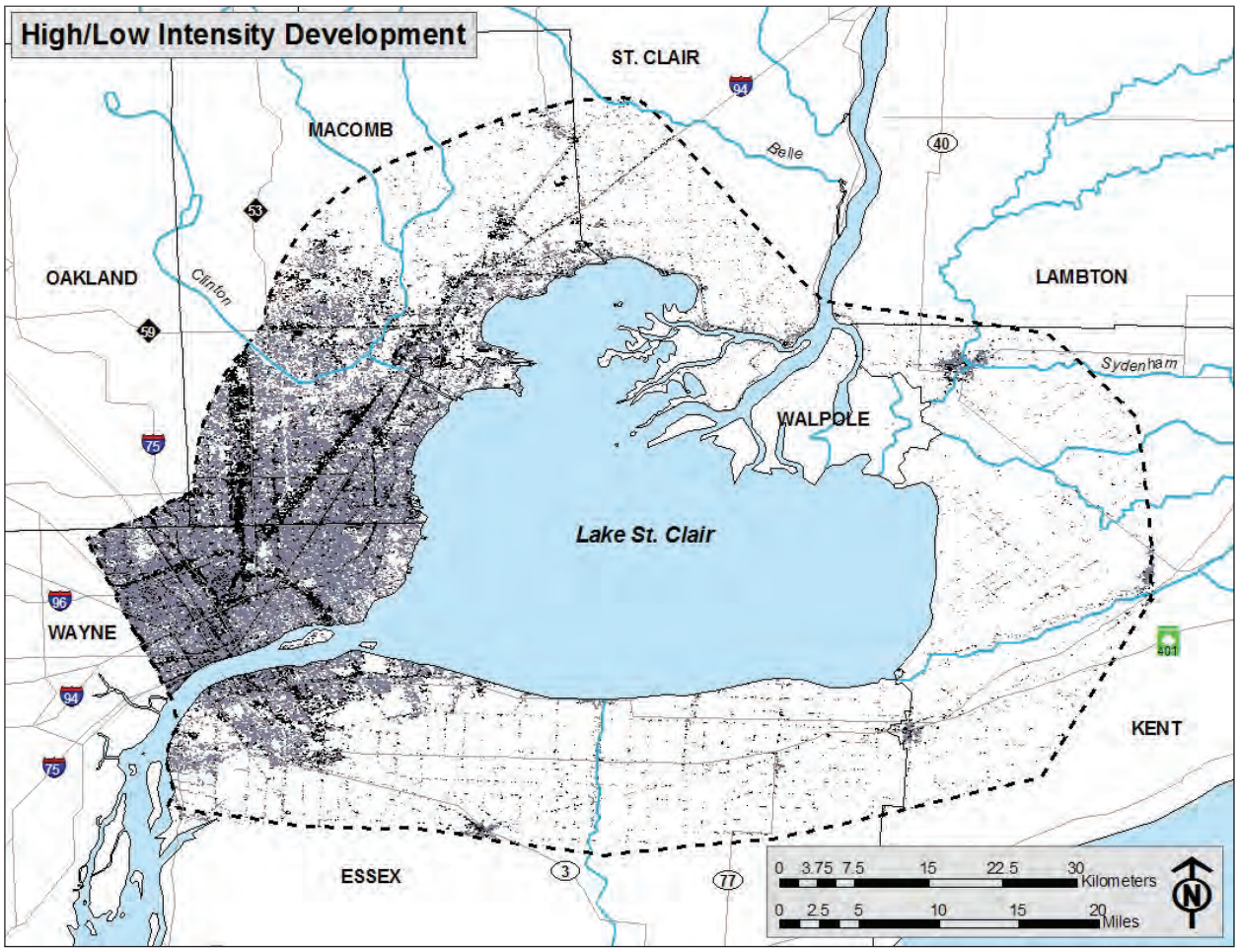


Figure IV A 2 -1
High and low intensity developed lands

IV. A. 2. Low intensity developed lands

Low intensity developed lands are those with a mixture of constructed materials and vegetation. Constructed materials generally account for 50 to 70 percent of the total area. Suburban neighborhoods with single family housing are typical, but many land uses are represented here. Often, in land cover maps derived from satellite data, a tiny patch

of low intensity development will be surrounded by another land cover category, reflecting, for example, a cluster of farm buildings in the midst of agricultural fields[14]. Within the project area, about 125, 000 acres (50,585 hectares), or 16 percent of the total area, consist of low intensity developed lands, and again, these are concentrated in Michigan[15]. Although some of these areas may be quite rural, C-CAP considers constructed surfaces in determining whether or not an area is developed.

HIGHLIGHT

The low intensity developed land cover class includes built and unbuilt surfaces. Built areas account for approximately 50 to 70 percent of this land cover class.

As with high-intensity developed areas, low intensity developed areas also have little habitat value and areas that do provide habitat can be particularly significant given the relative scarcity of alternatives in these suburban areas. Low-intensity development will likely have more "open space" but much of this will be in the form of lawns and intensively managed green space around buildings--still with little habitat value. The incremental ecological significance of these areas will depend on the extent to which the green space is managed to provide some habitat value (e.g., as a wetland) or biological diversity (wet meadow versus turf). Again, large parks that are connected to large habitat patches outside urban areas can serve as important ecological corridors.

IV. A. 3. Cultivated Land

Cultivated lands are those that have been planted, tilled, or harvested. Orchards, groves and nurseries are cultivated lands with crops that are produced on woody, single stemmed trees, such as apples, cherries, peaches and nuts. Tree nurseries that provide seedlings for the plantation industry are included in cultivated lands as well, although pine plantations without a visible geometric pattern are assigned to the category "Evergreen Forest"[16]. Cultivated lands also include areas that are planted with vines and bushes, woody, multi-stemmed plants which produce crops such as berries, grapes and nuts. In the Essex/Chatham Kent region, for example, berries and grapes are a common crop[17]. Common row crops in both the Canadian and U.S. portions of the project area include soybeans, corn and wheat[18, 19, 20]. Croplands are lands that are planted to row crops such as corn, soybeans or rye on a regular basis. Within the C-CAP classification scheme, the category reflects the land's status at a specific time. For example, fields which are left fallow as part of a rotation schedule are classified as grasslands during that time and as croplands only when they are actively being cultivated. C-CAP used a three season classification system in Michigan and a two-season classification system in Canada. Croplands can also include lands devoted to seed production, and sod farms[21].

FACT

Historically, agriculture has been very important in the project area; farms lined the western shore of Lake St. Clair by the late 1800s.

Historically, agriculture has been very important in the project area; farms lined the western shore of Lake St. Clair by the late 1800s[22]. As Detroit, and to a much lesser extent, Windsor began to grow, agriculture declined in importance, but it continues to play an important role further north, particularly in the Canadian portion of the project area, where it constitutes over 77 percent of the project area.

Cultivated lands make up the single largest category of land cover within the project area, occupying almost 50 percent of the total area, but most of these lands are in the Canadian portion. In 1995, they occupied 386,037 acres (156,223 hectares) and decreased to 377,987 acres (152,996 hectares) in 2000, a 2 percent loss[23]. In some ways, this figure obscures the shift away from agriculture in the U.S. portion of the project area, as the rapid change in southeastern Michigan is diluted by the sheer number of acres still in agricultural production in the Canadian portion. On the Michigan side of Lake St. Clair, the greatest losses of cultivated land were in Macomb County where development is extending north from the Detroit area. On the Ontario side of the lake, development is concentrated on the southern shore of

the lake, while most of the eastern shore is still primarily agricultural[24]. The vast majority of cultivated lands occur in Ontario, but smaller patches also occur in the Michigan portion of the project area[25]. The amount of land occupied by agriculture and its relative contribution to the economy in the region have decreased over the years, but the potential impact of agricultural practices on environmental quality is still enormous, particularly as it affects water quality in wetlands, streams, rivers, and Lake St. Clair itself.

Cultivated Lands

Regionally, the seven county area of southeast Michigan has experienced a 13 percent loss in agricultural lands between 1990 and 2000[26]. The three southeast Michigan counties that lie partially within the study area lost 63,900 acres (25,859 hectares) of agricultural land--a 15.4 percent loss. The agricultural land losses are primarily due to development (See Section 2. A. 4. b. Land use trends).

HIGHLIGHT

Cultivated lands make up the single largest category of land cover within the project area, occupying almost 50 percent of the total area, but most of these lands are in the Canadian portion.

The overall habitat value of cultivated lands ranges widely, depending on a number of factors. Agriculture has been implicated in the decline of about 40% of endangered species, and historically, was the primary cause of habitat loss and fragmentation in the lower 48 states[27, 28]. Providing connections between the remaining areas of high quality habitat is critical. Fencerows along roads, windbreaks and shelter belts between fields can provide both food and cover for birds, small mammals, and some reptiles and amphibians, as well as vital linkages or corridors between larger habitat patches. Additionally, they attract pollinators and other beneficial insects. Within these corridors, native plants which provide berries, nectar or seeds are particularly valuable for wildlife. Unfortunately, fencerows are disappearing as the size of farm fields increases. Vegetative buffers along stream corridors can provide additional habitat, as over 70% of all terrestrial animal species use stream corridors at some point in their life cycle[29]. Buffers also improve water quality by preventing erosion and filtering out fertilizer and agricultural chemicals.

The habitat value of row crops tends to be low, but a few avian species such as horned lark, killdeer and vesper sparrow will use them for breeding, and others such as ring-necked pheasant, American crow, American kestrel and barn swallow will forage in them regularly. Mammals such as white-footed deer mouse and meadow vole are also attracted to croplands, and are a valuable food source for predators although they are generally considered pests[30, 31].

FACT

Agriculture has been implicated in the decline of about 40% of endangered species, and historically, was the primary cause of habitat loss and fragmentation in the lower 48 states.

Row crops can also provide a critical resource for migratory and over wintering birds. Waste grains in agricultural fields around Lake St. Clair provide a valuable supplement to marsh vegetation for dabbling ducks such as mallard, American black duck, American wi-

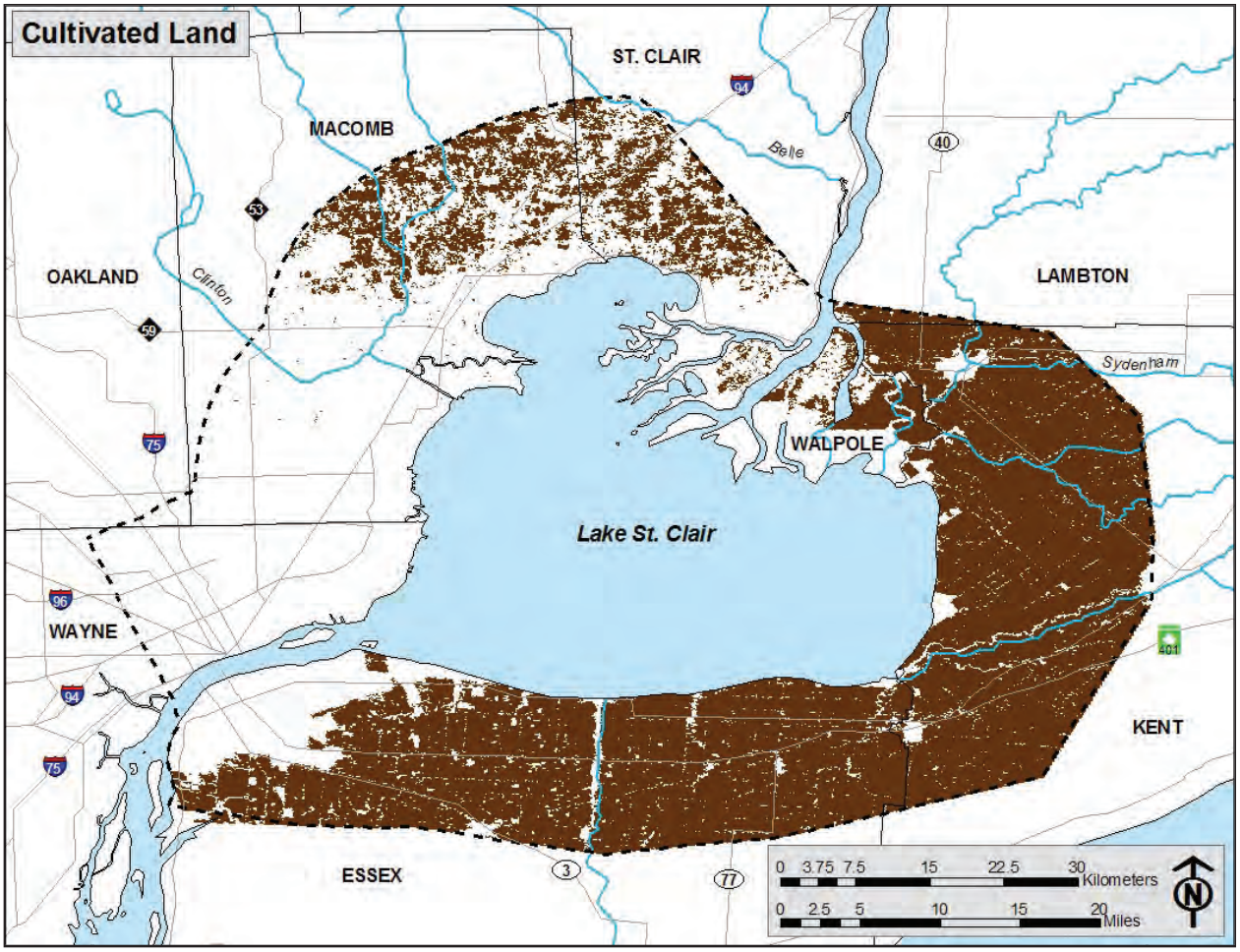


Figure IV A 3 - 1
Cultivated Lands

geon, green-winged teal, blue-winged teal, northern pintail and wood duck[32]. Large numbers of black-bellied and American golden plover have been reported from agricultural fields along the eastern shore of Lake St. Clair during spring migration[33], and when fields are flooded, species such as dunlins and ruddy turnstones are also present (Paul Pratt, 2004, personal communication).

In some cases, the use of cultivated crops by wildlife may lead to what is quite reasonably considered "wildlife damage" by farmers. In spite of this, it is often possible to encourage targeted species, while minimizing damage from pest species. Orchards with grassy herbaceous groundcover can provide cover, forage and nest sites for species such as eastern kingbird, eastern bluebird, orchard oriole and northern bobwhite. While small mammals may become pests, predators such as American kestrel and eastern screech-owl readily use nest boxes and can help keep their populations in check[34, 35].

FACT
Waste grains in agricultural fields around Lake St. Clair provide a valuable supplement to marsh vegetation for dabbling ducks.

Many of the structures associated with agricultural land uses have provided valuable habitat as well; holes in wooden fence posts provide nest cavities for eastern bluebird and barns and silos provide nest sites for birds such as eastern phoebe, barn owl and cliff and barn swallows[36, 37].

Timing of activities such as mowing, cultivating, and pesticide application has a huge impact on the habitat value of cultivated lands; if disruption can be avoided during the breeding season (i.e., spring and early summer) the lands may provide opportunities for breeding and foraging. While organic farming is clearly preferable for wildlife, restricting the use of pesticides until later in the season affords some degree of protection to birds which normally eat plant based foods, but rely on insects for feeding nestlings[38].

HIGHLIGHT

Timing of activities such as mowing, cultivating, and pesticide application has a huge impact on the habitat value of cultivated lands.

Agricultural lands have attributes that both sustain habitats and degrade them. Land stewardship is a key issue for agriculture. Intensive monoculture, tilled row cropping with no buffers, and high uses of pesticides and fertilizers bode poorly for habitats and the ecosystem while sustainable agricultural practices such as buffer strips, integrated pest management, and minimum tillage can allow these lands to retain some habitat value.

IV. A. 4. Grassland

Grasslands are covered with herbaceous vegetation such as grasses, sedges, and forbs or wildflowers and have less than 10 percent of their area covered by woody species. Within the C-CAP classification system, they include managed landscapes, such as parks, golf courses and cemeteries, as well as natural habitats such as prairies, meadows and fens. They

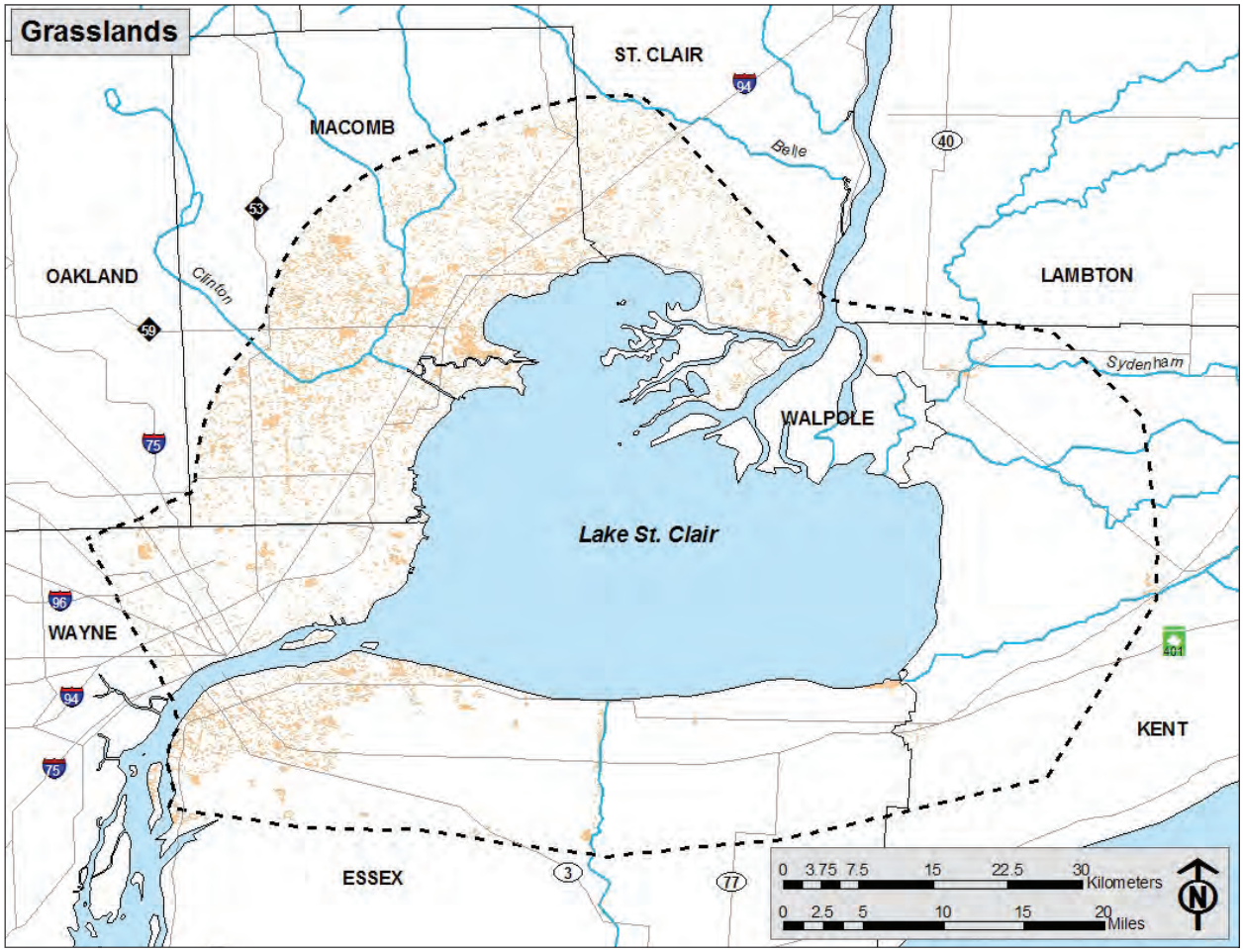


Figure IV A 4 - 1
Grasslands

also can include cultural grasslands, such as pasture, hayfields and rangeland, which are not fertilized and may or may not be mowed, but do not necessarily consist of native species[39]. Within the project area, grassland has increased from about 54,500 acres (22,055 hectares) in 1995 to about 58,000 acres (23,471 hectares) in 2000, an increase of 7.1 percent. The majority of this increase is due to agricultural fields that have been taken out of cultivation[40].

HIGHLIGHT

Native grassland communities such as lakeplain prairie are among the region's rarest, and are considered globally imperiled.

The habitat value of these lands varies tremendously; old, neglected cemeteries often function as refugia for prairie plants, and fallow fields may have considerable habitat value for wildlife, but the mowed lawns of parks and golf courses have little to offer.

Native grassland communities such as lakeplain prairie are among the region's rarest, and are considered globally imperiled. Historically, Wayne, Macomb and St. Clair Counties had over 60,000 acres (24,281 hectares) of lakeplain prairie. Today, less than 1,000 acres (405 hectares) remain in Wayne and St. Clair Counties[41]. In Ontario, similar losses have occurred, with less than 1 percent of the original prairie cover remaining[42]. Because of the way that C-CAP classifies land cover categories, lakeplain mesic sand prairie, the upland form of this grassland community will be discussed within this section. Two wetland forms of lakeplain prairie are included with emergent wetlands (see section II.C.2.b.2. Lakeplain wet prairie & lakeplain wet-mesic prairie). Another similarly related habitat, lakeplain oak opening, is included with upland deciduous forest communities (see section II.C.1.e.3. Lakeplain oak opening/oak savanna).

While a few rare species can only survive in native grasslands, many others can persist in a wider range of grassland types. Ring-necked pheasants, for example, are surprisingly common in the unmowed vacant lots of Detroit. With the decline in agriculture in the area, however, cultural grasslands such as hayfields and pastures are disappearing rapidly. Grassland quality is not the only factor affecting habitat suitability; for many vulnerable species, area is a critical factor. Species such as bobolink, savanna sparrow, Henslow's sparrow (*http://web4.msue.msu.edu/mnfi/abstracts/zoology/Ammodramus_henslowii.pdf*) and upland sandpiper are most likely to occur on parcels larger than 140 acres (57 hectares)[43, 44, 45]. In a fragmented landscape, these parcels are increasingly rare, and will not persist without deliberate planning.

Ojibway Prairie Provincial Nature Reserve, Windsor

IV. A.4.a. Cultural grasslands and old fields

Pastures and hayfields are lands that are planted with grasses, legumes or a mixture of both, and used either for livestock grazing, or the production of hay or seed. Typically, they are planted with perennials, and not tilled[46]. Hayfields differ from pastures in that they are cut two or three times a year for hay, while pastures are grazed by livestock that may remove part or all of the vegetation during the growing season. Fallow fields are fields that are no longer being cultivated, but have been plowed in the last three years. Fields that haven't been plowed in the last three years fall into the category of old field, and if left indefinitely, will be invaded by shrubs.

FACT

Mowing in spring can destroy nests and nesting birds; delaying harvest until late June or July allows birds to nest successfully at least once during the breeding season.

Hayfields are planted specifically for hay production and traditionally have been planted with cool season grasses such as timothy, orchard grass and tall fescue, and legumes, such as alfalfa and white clover. Warm season, native grasses such as switchgrass, big bluestem and Indian grass can also be utilized. Hayfields can be harvested from one to three times a year and the timing of mowing is a critical factor affecting the habitat potential of a particular piece of land. Mowing in spring can destroy nests and nesting birds, a particular problem with alfalfa, which is harvested early in the season. Delaying harvest until late June or July allows birds to nest successfully at least once during the breeding season[47, 48].

Pasture is also often planted with desirable grasses and/or legumes, but differs in that it is not mowed but rather grazed by livestock. The habitat value of pasture varies with the length of time that livestock remain in a given area; in pastures that are grazed continuously, habitat value is low; while livestock may be able to graze without destroying active bird nests, as cover is removed, predation increases. When pastures are rotationally grazed, in contrast, many more birds and more species are able to breed successfully[49, 50].

Photo: Norm Klopfenstein, Natural Resources Conservation Service

Fallow fields are increasingly an indication that the land is no longer being farmed, but may also be a stage in a planned crop rotation. As part of a crop rotation, the land is often planted with a cover crop, which can provide benefits to both the soil and wildlife[51]. If the land is no longer being farmed it initially has bare soil exposed but is gradually invaded by sun-loving annuals such as ragweed, lamb's quarters and foxtail. By the third year, perennial grasses and forbs are more common, with typical species including brome grass, goldenrod, daisy fleabane and spotted knapweed.

HIGHLIGHT

Timing of activities such as mowing, cultivating, and pesticide application has a huge impact on the habitat value of cultivated lands.

If left uncultivated for more than three years, fallow fields are categorized as old fields and are dominated by perennial grasses and forbs, with widely scattered shrubs. Typically, old fields are dominated by non-native grasses such as smooth brome, quackgrass, timothy and orchard grass. Common forbs include Queen Anne's Lace, chicory, goldenrods, asters, daisy fleabane, spotted knapweed, clover, sweet clover, mullein, curly dock and thistles. Unless the field is mowed or burned regularly, within 5 or 10 years it will gradually be invaded by shrubs to become shrub/scrub lands (to be discussed in Section IV. A. 8. Scrub/shrub)[52].

A number of species utilize cultural grasslands, particularly if shelterbelts and fencerows are left in the area. Common birds that nest in them include American kestrel, eastern kingbird, eastern bluebird, savanna sparrow, vesper sparrow,

chipping sparrow, field sparrow, song sparrow, bobolink, red-winged blackbird, mallard, blue-winged teal, northern bobwhite quail, killdeer, eastern meadowlark, American goldfinch and brown thrasher. Red-tailed hawk, northern harrier (*http://web4.msue.msu.edu/mnfi/abstracts/zoology/Circus_cyaneus.pdf*) and swallows commonly forage in them[53, 54]. Cultural grasslands and old fields also provide habitat for a number of small mammals including eastern mole, masked shrew, northern short-tailed shrew, meadow vole, deer mouse, least weasel, woodchuck and thirteen-lined ground squirrel. Larger mammals include red fox, American badger, and white-tailed deer[55].

FACT

Rare species that utilize cultural grasslands include grasshopper sparrow, Henslow's sparrow, northern harrier and short-eared owl.

Rare species that utilize cultural grasslands include grasshopper sparrow (Species of special concern), Henslow's sparrow (Threatened - *http://web4.msue.msu.edu/mnfi/abstracts/zoology/Ammodramus_henslowii.pdf*), northern harrier (Species of special consern - *http://web4.msue.msu.edu/mnfi/abstracts/zoology/Circus_cyaneus.pdf*) and short-eared owl (Endangered - *http://web4.msue.msu.edu/mnfi/abstracts/zoology/Asio_flammeus.pdf*)[56].

IV. A. 4. b. Lakeplain mesic sand prairie

Lakeplain mesic sand prairies are the driest sort of lakeplain prairies and are found inland from the lake, in sand deposits within the silt or clay glacial lakeplain. They may experience high water tables in spring but are subject to drought later in the summer. Soils range from loam to medium sand, and have a wide range of pH values (5.4 to 8.0). They do not flood, but can remain moist through spring[57, 58, 59]. As mentioned earlier, lakeplain mesic sand prairies are considered globally endangered but publicly accessible examples still can be found within the project area in the Ojibway Prairie Complex in Windsor and in Algonac State Park. The largest remaining areas of lakeplain prairie and lakeplain oak opening occur on Walpole Island.

Great spangled fritillary on butterfly milkweed

Although lakeplain mesic sand prairies are the driest of three types, in general, lakeplain prairies tend to be moister than prairies found further west and have many more wildflowers. Typically, trees do not grow in prairies because there is not enough rainfall. In contrast, in lakeplain prairies trees do not establish because there is too much water[60]. Lakeplain prairies occur in sandy areas that lie over clay lakeplain. In spring, as winter snows melt, the water accumulates on the clay layer, creating a seasonally high water table. Historically, these prairies occupied the space between Great Lakes marshes and forest further inland. As water levels rose, trees would be flooded out and prairie would expand into the newly opened area. As water levels fell, trees would once again begin to grow and the prairies would shift closer to the lake and contract in size. In many areas, the natural fluctuation of the water levels has been eliminated, jeopardizing the long-term survival of these communities[61].

Fire has been another significant factor in the maintenance of lakeplain prairie. The combination of accumulated plant fuels and summer drought made these systems prone to wildfires and limited the spread of woody vegetation. Prairie

species are adapted to frequent fires and in some cases require them for seed germination. Fire prevents invasion by woody plants, selects against many non-native species, converts the stubble and dead vegetation of the previous year to nutrients and exposes the soil for warming early in spring. It is particularly critical for the shorter species, which often bloom early in spring. When shaded by tall dead vegetation, they cannot obtain adequate energy from the sun to flower and fail to bloom or die out completely.

Historically, Native Americans used fire as a management tool to clear land and create habitat for game and this was a significant factor in maintaining prairie in the area in the past. Initially, early settlers adopted the Native Americans' methods but as the land became more developed, fire was suppressed in most areas. Without fire, prairies have converted to scrub lands, savanna and forest[62, 63].

Management of lakeplain mesic sand prairie remnants includes restoring natural hydrology when possible and restoring a natural fire regime with prescribed burning. Invasive species such as honeysuckle, common buckthorn, spotted knapweed and sweet white clover must be controlled as they can often out-compete the native species. Aggressive native shrubs such as dogwoods, hawthorns and prickly ash must also be controlled to prevent the shading out of prairie grasses and forbs[64].

Little Bluestem

Typical plant species in mesic sand lakeplain prairie include little bluestem, Penn sedge, yellow wild indigo, roundheaded bush clover, butterfly milkweed, wood rush, sky-blue aster, early goldenrod, grey goldenrod, rigid goldenrod, rough blazing star and tall coreopsis[65, 66, 67].

Grassland bird populations have been declining in recent years and prairies provide critical habitat for such species as bobolink, eastern meadowlark, savanna sparrow, eastern kingbird, vesper sparrow, northern bobwhite, field sparrow and upland sandpiper[68, 69]. Typical mammals found in prairies include northern short-tailed shrew, thirteen-lined ground squirrel, deer mouse, meadow vole, American badger and white-tailed deer[70].

Rare plants that are found in lakeplain mesic sand prairie include white false indigo (Species of special concern), trailing wild bean (Species of special concern) and pink milkwort (Extirpated in Michigan, Endangered in Canada)[71, 72]. Rare animals include blazing star borer (Species of special concern - *http://web4.msue.msu.edu/mnfi/abstracts/zoology/Papaipema_beeriana.pdf*), Culver's root borer (Species of special concern - *http://web4.msue.msu.edu/mnfi/abstracts/zoology/Papaipema_sciata.pdf*), red-legged spittlebug (Species of special concern - *http://web4.msue.msu.edu/mnfi/abstracts/zoology/Prosapia_ignipectus.pdf*), northern harrier (Species of special concern - *http://web4.msue.msu.edu/mnfi/abstracts/zoology/Circus_cyaneus.pdf*), Short-eared owl (Endangered - *http://web4.msue.msu.edu/mnfi/abstracts/zoology/Asio_flammeus.pdf*), Cooper's hawk (State species of special concern - *http://web4.msue.msu.edu/mnfi/abstracts/zoology/Accipiter_cooperii.pdf*), Henslow's sparrow (Threatened - *http://web4.msue.msu.edu/mnfi/abstracts/zoology/Ammodramus_henslowii.pdf*), grasshopper sparrow (Species of special concern) and migrant loggerhead shrike (Endangered - *http://web4.msue.msu.edu/mnfi/abstracts/zoology/Lanius_ludovicianus_migrans.pdf*)[73, 74, 75, 76, 77].

CASE STUDY

Walpole Island's rare plants, animals and natural communities[78]

Walpole Island is in the species rich Carolinian Zone of southern Ontario and supports a rich mosaic of natural areas and features of global importance. These include Carolinian forest, coastal waterways, one of the largest wetland systems in the Great Lakes Basin and large areas of tallgrass prairie and oak savanna. These ecosystems provide habitat for many rare plant and animal species including some that occur nowhere else in Canada. The people of Walpole Island First Nation have lived off the land and successfully managed these ecosystems for thousands of years. Traditional philosophies, practices and values have contributed to the maintenance of these ecosystems and the species they support on Walpole Island, while they have been lost or severely fragmented on adjacent land.

Some 108 plant species, 2 mammals, 24 birds, 11 reptiles, 11 fish, 12 lepidoptera and 27 mussels that are found on Walpole Island are considered rare in Ontario (Appendix 1). Many species are considered rare in Canada because they are at the extreme northern limit of their range. Such have often have high evolutionary significance for the species as a whole because they may be genetically and morphologically divergent from the central populations[79].

Of the vascular plant species, eight are listed as Endangered and six as Threatened in Canada to date. At least three species - white prairie gentian, showy goldenrod and chestnut sedge are found nowhere else in Canada and several other plants have their Canadian stronghold on Walpole Island. Some of these, of which dense blazing-star is an excellent example, are not at all rare on Walpole Island. Most of these plants are prairie and savanna specialists, although some, like goldenseal, occur in woodland and forest.

Perhaps the most important bird considered at risk is the northern bobwhite. Natural populations of this species have been extirpated from mainland Canada. Although it is sometimes introduced as a game bird, re-introductions may not be sustainable on the mainland where habitat has been destroyed. On Walpole Island northern bobwhite is found throughout most of the prairies and savannas. Redhead, Canvasback and Ruddy Duck are other rare birds of potential economic importance.

The rarest fish found in the waters around Walpole Island is certainly northern madtom. This species is listed as Endangered in Canada and limited to extreme southwestern Ontario. Lake St. Clair is one of only three locations where it is found in Canada. Freshwater mussel species are suffering dramatic declines in populations throughout much of the Great Lakes region and the rest of North America. Eleven species of mussels once found in the waters around Walpole Island may now be extirpated, but on the other hand some areas of the shoreline, where invasion by zebra mussels seem to be restricted, may be providing an important refuge for native mussels. This may provide an opportunity for recovery of some of the most threatened species[80].

Natural Communities

The islands of Walpole Island First Nation form part of what has been described as "a splendid example of a bird's-foot delta", with channels that spread from north to south[81]. Generally the land is flat and low-lying, but highest at the north end of the complex and around the edge. Poor drainage due to high water levels is prevalent throughout the islands. A series of dikes separates the land from extensive marshes to the south that make up most of the delta.

The deltaic deposits of Walpole Island form a complex of gently grading ridges and sloughs with different moisture regimes that support a diversity of vegetation communities[82]. The deposits are composed mainly of fine to medium sands and coarse silts that have been carried down the St. Clair River. The soils of Walpole Island have these deposits as their parent materials and are mostly imperfectly to poorly drained fine sandy loams, but pockets of sand are present at the north end of the island. Low-lying wet areas have additional silt and loams[83]. Chernozemic soils that have developed under prairie are very distinctive and are well represented on Walpole Island[84].

Tallgrass Prairies

Many of the prairies on Walpole Island are in excellent condition because of the regular burns that occur. They represent the most outstanding prairie complex in Ontario, with the greatest species richness[85] and a high concentration of rare species. There are 110 prairie indicator plant species that have been recorded here. Some of the prairies many have expanded since the First Nations started maintaining a permanent settlement on the islands in the early 1800s. Other areas have more recently been lost to agricultural and development. Estimates from 1972 and 1998 air photos suggest that prairies at Walpole Island have been reduced from about 730 ha (1,804 acres) to about 470 ha (1,161 acres), a loss of 36%[86]. Some of

this is a result of conversion to agriculture and housing, but most is due to encroachment by forest and woodland in the absence of regular fires.

All the prairie vegetation types and ecosites that are found on Walpole Island are considered extremely rare in Ontario and have a provincial ranking of S1[87].

Oak Savanna
Walpole Island contains some of the most significant areas of oak savanna remaining in Canada. Increasing development on Walpole Island means that the use of fire to manage and maintain savannas has been reduced. An estimated 570 ha (1,409 acres) of oak savanna in 1972, based on aerial photography, was reduced to some 360 ha (890 acres) by 1998, a 37% loss mainly attributable to closing in of the tree canopy. All oak savanna vegetation types are considered extremely rare in Ontario with a provincial ranking of S1.

Deciduous Forests
On Walpole Island, forest and woodland occupies some 1780 ha (4,398 acres). Much of it is on wetter soils and not all is considered well-developed, mature Carolinian forest. The amount of forest on Walpole Island has increased almost 400 ha (988 acres) since 1972 as a result of the growing in of savanna. These younger forests are losing or have lost the characteristic savanna elements and do not have the same structural and species diversity as older forest ecosystems. For recovery and management purposes it is important to distinguish the areas that should be protected as "true" forest from treed areas that are overgrown savannas that may need to be restored.

Marshes
Walpole Island contains over 12,000 ha (29,600 acres) of World Class Wetlands, one of the largest wetland complexes in the Great Lake basin, composed primarily of cattail and sedge marshes, swamps and swales[88]. The wetlands on Walpole Island are an enormously important resource that forms the economic base of the community through fishing, hunting and harvesting other aquatic life. The marshes at the south end of Walpole Island are an important staging area for migrating waterfowl on the Atlantic and Central Mississippi flyways. Since European settlement some 88 percent of the original wetlands in Lambton County and Chatham Kent have been drained[89]. On Walpole, St. Anne, Squirrel and Pottawatamie Islands of the Walpole Island First Nation about 6,240 ha (13,350 acres) of the original wetlands have been drained and converted to farmland since the 1910.

About 88% of the Walpole Island marshes are currently diked for waterfowl management. The first dikes were installed in the early 1950s and diking has continued as recently as 2002. Waterfowl hunting is an economic mainstay for Walpole Island. Hunting by individuals takes place and there are six hunting clubs. The Walpole Island Marsh Committee manages two baited sanctuaries in addition to sanctuaries operated by each of the hunting clubs.

Open water Coastal Communities
The open water and coastal communities of Walpole Island First Nation occupy the south channel of the St. Clair River, the Bassett Channel, the Johnston Channel and the Chenail Ecarte (The Snye) as well as Goose Lake and many smaller openings in the marshes. In the south the marshes open up and grade into several square kilometres of open water in Lake St Clair including Walpole and Johnston Bays. These open water areas share their economic and ecological importance with the wetlands. Most of the banks of the St. Clair River and Chenail Ecarte are hardened.

The Sydenham River, one of the most biologically rich rivers in southern Ontario, enters the Chenail Ecarte opposite St. Anne Island. In addition to waterfowl and fish, the freshwater mussel population is particularly diverse in the Sydenham River and Lake St. Clair and includes several species at risk. What appears to be an important refugium for freshwater mussels from Zebra Mussel infestations has been found in the waters of WIFN, and is being studied by Environment Canada.

IV. A. 5. Deciduous forest

Within the C-CAP classification scheme, deciduous forests are lands that have at least 20 percent tree cover, composed of species that lose their leaves in response to seasonal changes. It includes southern mesic dry forest, southern mesic forest and lakeplain oak opening. C-CAP satellite data can also include developed areas with dense tree canopy such as the Grosse Pointes (located just north of Detroit) in this land cover category. Deciduous forest has decreased within the project area from over 54,000 acres (21,853 hectares) in 1995 to about 53,000 acres (21,448 hectares) in 2000, a decrease of about 2.5 percent. The largest losses were due to development.

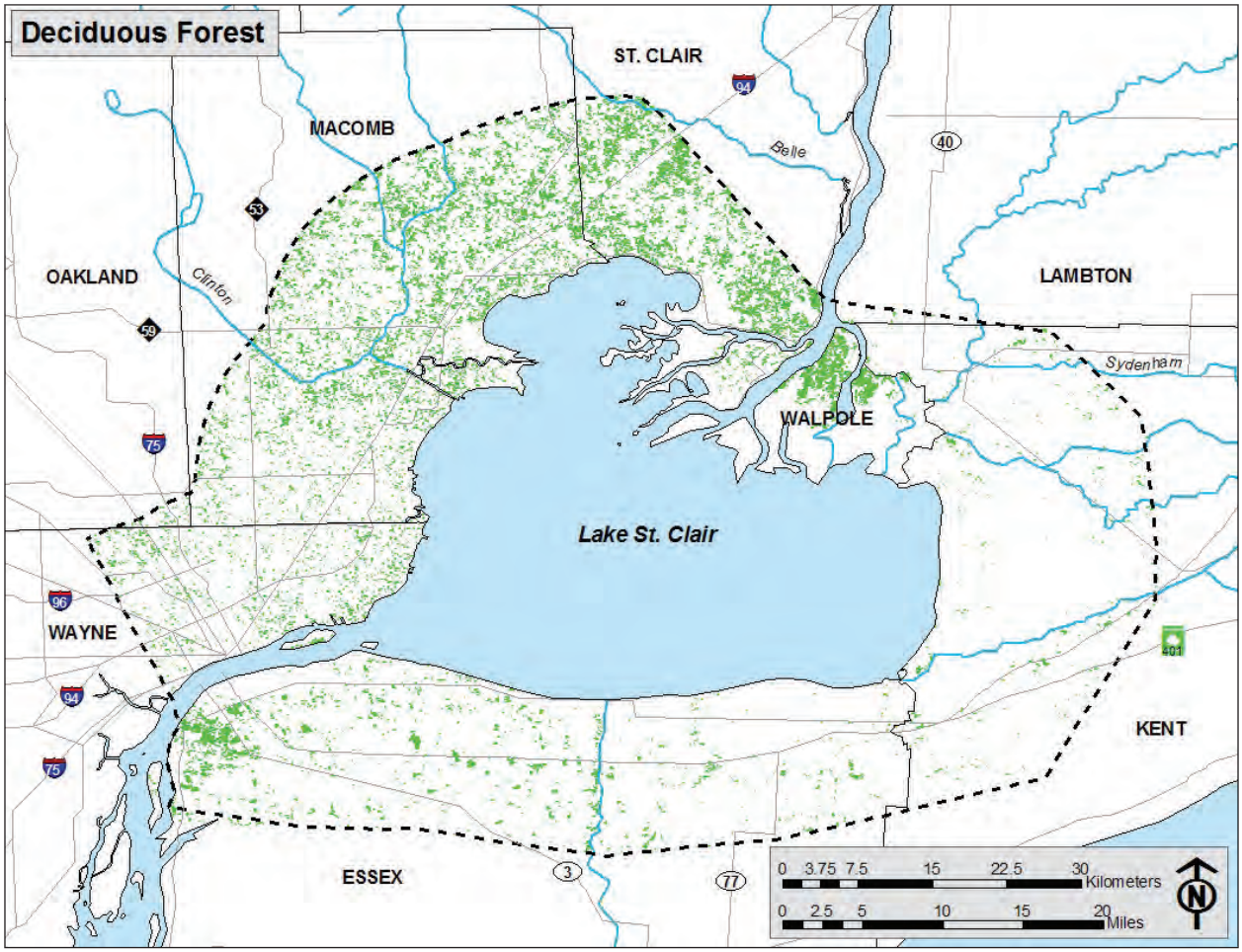


Figure IV A 5 - 1
Deciduous forest

Historically, much of the project area was forested, but by the late 1800s the majority of forest had been logged and converted to agriculture. Of the remaining woodlands, most exist as small, unconnected patches. For small animals, roads, parking lots and even lawns may form an effective barrier to movement. In addition, the amount of forest interior is a critical factor for many species. Cerulean warbler (*http://web4.msue.msu.edu/mnfi/abstracts/zoology/Dendroica_cerulea.pdf*) and scarlet tanager, for example, both require large expanses of forest to nest successfully. As forest patches shrink the amount of "edge" increases in relation to forest interior. Forest birds are particularly vulnerable to this edge effect as the brown-headed cowbird, a nest parasite, thrives at the forest edge. Although some species such as white-tailed deer or yellow-billed cuckoo prefer edge and have increased their range since the forests were cleared, it is generally the more common animals which have increased at the expense of the rarer species.

IV. A. 5. a. Dry mesic southern forest

Dry mesic southern forest is an oak and hickory dominated forest type, which is located in the southern portion of the state. It occurs on well drained, sandy loam or loam soils that are slightly acid to neutral. Typically, it occurs on coarse-textured moraines, glacial outwash, kames and sand lakeplain[90]. It is relatively uncommon within the project area as the water table tends to be high and heavy clay soils are prevalent. Historically, dry mesic southern forest covered less than 1 percent of the project area and most of this was located in and around the present day city of Algonac[91]. A portion of this forest is preserved within Algonac State Park.

FACT

In the past, oak-hickory forests were maintained by fire. Their droughty soils and characteristic southern exposures made them susceptible to natural fires prior to European settlement.

In the past, oak-hickory forests were maintained by fire. Their droughty soils and characteristic southern exposures made them susceptible to natural fires prior to European settlement[92]. Fire was also used by Native Americans as a management tool to keep the forest understory open and stimulate the regrowth of ground layer vegetation for game species such as white-tailed deer[93]. Most oaks have thick bark and can tolerate frequent fires. Additionally, they grow back from root sprouts following particularly severe fires. Because more mesic species cannot survive in these conditions, oaks were able to successfully compete. With the suppression of fire beginning in the 1930s, however, oak hickory forests have been invaded by more mesic species such as red maple which are gradually replacing young oak trees in the understory[94]. Oaks are not tolerant of shade and oak seedlings will not survive in the forest floor unless an opening is created. On particularly steep slopes they may still persist as light is better able to penetrate but for the most part, oaks will not regenerate without some sort of disturbance to open the forest canopy[95, 96].

New Jersey Tea

Dominant tree species in dry mesic southern forest include white oak, black oak, red oak and pignut hickory. Within the project area, bur oak assumes a more prominent role than it does elsewhere and scarlet oak is also frequent. Other common associates may include black cherry, shagbark hickory, sassafras, black walnut, white ash and ironwood. In the understory, species such as flowering dogwood, gray dogwood, witch-hazel, arrow-wood viburnum, maple-leaved viburnum, blueberries, huckleberries and New Jersey Tea are common. Historically, American chestnut would have been an important component of this community but its populations were devastated by the chestnut blight[97, 98].

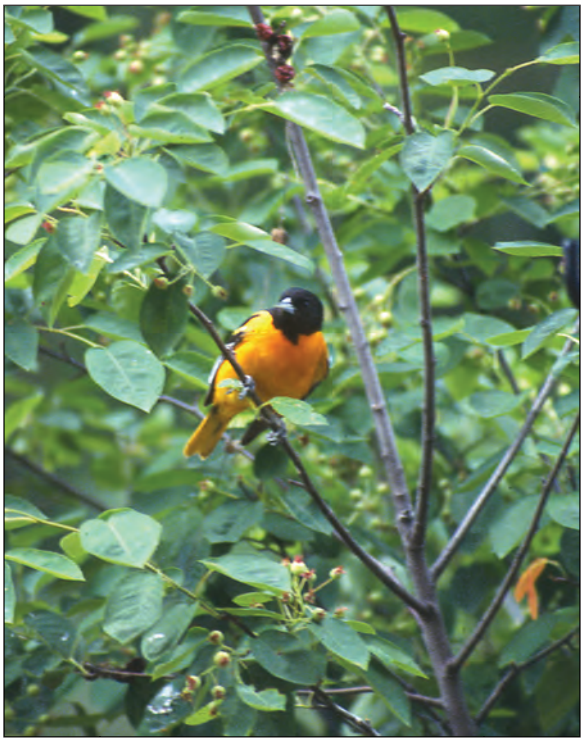
FACT

Because sufficient light is available from the open canopies of the dry mesic forests, plants in the groundlayer bloom thoughout the growing season.

Dry mesic forests tend to have a more open canopy than mesic forest types and relatively high levels of light reach the forest floor[99]. Because sufficient light is available, plants in the groundlayer bloom thoughout the growing season[100]. Early blooming species include wood anemone, Penn sedge, wild geranium, blue cohosh and Solomon's seal. Ferns such as maidenhair fern, bracken fern, and interrupted fern are common also. Later in the season, bottlebrush grass, clustered-leaved tick trefoil, tall white lettuce, spreading dogbane and blue-stemmed goldenrod are typical[101].

Dry-mesic forests are rich in a variety of animal foods and acorns and hickory nuts are a particularly valuable crop for wildlife. Small mammals such as gray, flying and fox squirrel and eastern chipmunk are common, as well as raccoon, Virginia opossum, white-tailed deer and red fox. Typical bird species that frequent dry mesic forests include scarlet tanager, black-capped chickadee, downy woodpecker, rose-breasted grosbeak, northern cardinal, blue jay, northern oriole and red-headed woodpecker. Other common avian inhabitants include wild turkey, eastern wood-peewee, great crested flycatcher, blue jay, black-capped chickadee, tufted titmouse, white-breasted nuthatch, yellow-throated vireo and ovenbird[102, 103].

Rare plants found in southern dry-mesic forest include Virginia snakeroot (State threatened - *http://web4.msue.msu.edu/mnfi/abstracts/botany/Aristolochia_serpentaria.pdf*), fire pink (State threatened) and tinted spurge (State threatened - *http://web4.msue.msu.edu/mnfi/abstracts/botany/Euphorbia_commutata.pdf*)[104].



Northern Oriole

IV. A. 5. b. Mesic southern forest

Mesic southern forest (*http://web4.msue.msu.edu/mnfi/abstracts/botany/Trillium_undulatum.pdf*) is typically dominated by American beech and sugar maple. Within the project area, it occurs on the moist, rich soils of silty, clayey glacial lakeplain, where it often grades into southern swamp[105]. Elsewhere in the state, it is common on medium or fine-textured ground moraine, and fine textured end moraine on soils which range from loams to clays[106]. Historically, beech-maple forest covered half of the state, when both northern and southern forms were considered. Today, the majority lies in the northern portion of the state and makes up 19% of Michigan's forest. Within the project area, only small, isolated patches persist[107].

Sugar maple and American beech are extremely successful as forest dominants in much of the state because they are both very shade tolerant and their abundant seedlings can reproduce in the heavy shade of their canopy. Their abundant leaves are high in nutrients, and break down rapidly, enriching the soil. They are not fire tolerant but their leaf litter in spring and fall resists its passage. Once their dense canopy has closed in, species like oaks, which need high levels of light, gradually disappear from the forest[108].

On the glacial lakeplain, however, a number of factors interact to lessen this dominance. Sugar maple is sensitive to the wetter clay soils and does not compete as effectively on them. American beech is comparatively more successful on wet soils but because of the heavy clays, tree roots are shallow, and windthrow is more common, creating frequent gaps that shade intolerant species can exploit[109]. Because of this, mesic forest on the lakeplain differs from the beech-maple forest found elsewhere in the state. Dominant tree species in mesic forest in the project area include American beech, red oak, swamp white oak and bur oak. Although bur oak is normally considered a savanna species, it is also common on the clay soils of the Maumee lakeplain and was historically common in the Great Black Swamp of southeast-

HIGHLIGHT

Mesic forest on the lakeplain differs from the beech-maple forest found elsewhere in the state; dominant tree species in the project area include American beech, red oak, swamp white oak and bur oak.

ern Michigan and northwestern Ohio. Other tree species in mesic forest include basswood, white ash, yellow birch, black cherry, sugar maple, shagbark hickory, bitternut hickory, black walnut, tuliptree and historically, American elm[110, 111].

Bur oak leaves and bark

Light is a limiting factor in the understory during much of the growing season, as mesic forests have such a dense canopy. Over half of the wildflowers bloom early in spring before the trees leaf out. Many are ephemeral, with underground storage organs such as rhizomes, corms or bulbs, and bloom, set seed and die back by early summer. Ephemeral species include Dutchman's breeches, squirrel corn, trout lilies, and spring beauty. Other spring blooming species include common trillium, sweet cicely, wild geranium, bloodroot, wild ginger, hepatica, mayapple and wood phlox. Shade tolerant understory species include hop-hornbeam, flowering dogwood and maple-leaf viburnum[112].

These rich forests provide a variety of habitats that are used by invertebrates, amphibians, songbirds and mammals. Southern mesic forests are particularly important for salamanders which breed in ephemeral pools in spring. Typical species include spotted salamander, blue-spotted salamander and red-backed salamanders. White-tailed deer, raccoon, and Virginia opossum are common as well as a variety of small mammals such as white-footed deer mice, northern short-tailed shrew and masked shrew[113]. Birds in the southern mesic forest include red-bellied woodpecker, downy woodpecker, northern flicker, least flycatcher, Acadian flycatcher, ovenbird, wood thrush, red-eyed vireo, northern cardinal, white-breasted nuthatch, black-capped chickadee, eastern wood-peewee and rose-breasted grosbeak[114].

Rare plants in southern mesic forest include goldenseal (State species of special concern - *http://web4.msue.msu.edu/mnfi/abstracts/botany/Hydrastis_canadensis.pdf*), smooth carrion flower (State species of special concern), showy orchis (State species of special concern - *http://web4.msue.msu.edu/mnfi/abstracts/botany/Galearis_spectabilis.pdf*), Oswego tea (State endangered), ginseng (State threatened - *http://web4.msue.msu.edu/mnfi/abstracts/botany/Panax_quinquefolius.pdf*), cranefly orchid (State endangered), painted trillium (State endangered - *http://web4.msue.msu.edu/mnfi/abstracts/botany/Trillium_undulatum.pdf*) and prairie trillium (State species of special concern). The cerulean warbler (State species of special concern) is found here as well[115].

IV. A. 5. c. Lakeplain oak opening/oak savanna

Lakeplain oak openings (*http://web4.msue.msu.edu/mnfi/abstracts/ecology/Lakeplain_oak_opening.pdf*) are dominated by widely spaced oaks, with a ground layer that contains both forest and lakeplain prairie species. Like the closely related lakeplain prairies, they are considered globally imperiled. In the 1800s, surveyor's records showed 76,411 acres of lakeplain oak openings in the state. Today, about a thousand acres or 1.5% remain with comparable losses in Ontario[116, 117]. Lakeplain oak openings occur within the glacial lakeplain on sand ridges, level sandplains or within depressions. Typically, soils are sandy and mildly alkaline, but they can also occur on silty/clayey soils. On drier sites,

Lakeplain oak opening, Walpole Island First Nation
Photo: Laura Lodisio, USEPA

HIGHLIGHT

Lakeplain oak openings are dominated by widely spaced oaks, with a ground layer that contains both forest and lakeplain prairie species.

such as sandy beach ridges, black oak and white oak dominate. On poorly drained flat sites, bur oak, swamp white oak and pin oak form a wet savanna type[118, 119].

Like prairie, lakeplain oak openings are fire dependent systems. Differing fire regimes can produce very different results; frequent, low intensity fires create an open understory, and large spreading oaks, while infrequent, high intensity fires kill the trees and stimulate suckering[120, 121]. On drier sites, in the absence of fire, other trees grow up, and the oaks are eventually replaced by more shade tolerant species such as maples and beeches[122, 123, 124]. On wetter sites a high water table may inhibit some potential invaders[125].

In the dry-mesic lakeplain oak openings, scattered black and white oaks dominate and typical understory species include serviceberry, New Jersey Tea, gray dogwood and huckleberry. The groundlayer is dominated by graminoids including big bluestem, little bluestem, Indian grass and Penn sedge but ferns such as bracken fern and interrupted fern are common also. Typical wildflowers include bastard toadflax, hoary puccoon, false Solomon's seal, hog peanut, wood betony, woodland sunflower, yellow pimpernel, wild lupine, slender bushclover, arrow-leaved violet and yellow false foxglove[126, 127, 128].

On wetter sites, bur oak, pin oak and swamp white oak replace the dry-mesic oaks, and the understory includes buttonbush, silky dogwood and red-osier dogwood. Shellbark hickory may be present also. Graminoids include bluejoint grass, prairie cordgrass and sedges. A variety of ferns such as royal fern, marsh fern and sensitive fern are abundant. Common herbaceous species include starry false Solomon's seal, black snakeroot, ground-nut, Culver's root, tall coreopsis, Virginia mountain mint and prairie dock[129, 130, 131].

Yellow False Foxglove

Wild Lupine

Lakeplain oak openings provide habitat for many of the same invertebrates that utilize lakeplain prairie: wild indigo duskywing (State species of special concern), Culver's root borer (State species of special concern - *http://web4.msue.msu.edu/mnfi/abstracts/zoology/Papaipema_sciata.pdf*), blazing star borer (*http://web4.msue.msu.edu/mnfi/abstracts/zoology/Papaipema_beeriana.pdf*), silphium borer moth (State threatened - *http://web4.msue.msu.edu/mnfi/abstracts/zoology/Papaipema_silphii.pdf*) and red-legged spittlebug (State species of special concern - *http://web4.msue.msu.edu/mnfi/abstracts/zoology/Prosapia_ignipectus.pdf*). Many are intimately tied to host plants which are found only in high quality prairie and savanna. While fire is critical to the survival of oak openings, it is important that refugia be provided during burning to ensure the survival of these insects[132, 133].

HIGHLIGHT

Like prairie, lakeplain oak openings are fire dependent systems. Frequent, low intensity fires create an open understory, and large spreading oaks, while infrequent, high intensity fires kill the trees and stimulate suckering.

Lakeplain oak openings are also home to a wide variety of birds. Songbird species include indigo bunting, eastern towhee, chipping and field sparrow, eastern bluebird, American goldfinch, northern oriole, blue-winged warbler and brown thrasher. They are also used by red-headed woodpecker, sharp-shinned hawk, redtail hawk, eastern kingbird, mourning dove, American kestrel, upland sandpiper, killdeer, ruffed grouse and wild turkey[134].

Rare plants include Hill's thistle (State threatened - *http://web4.msue.msu.edu/mnfi/abstracts/botany/Cirsium_hillii.pdf*), Leiberg's panic grass (State threatened - *http://web4.msue.msu.edu/mnfi/abstracts/botany/Panicum_leibergii.pdf*), pale beardstongue (State threatened - *http://web4.msue.msu.edu/mnfi/abstracts/botany/Penstemon_calycosus.pdf*), wild bean (State endangered), honey-flowered Solomon's seal, (Federally listed endangered, State endangered), prairie buttercup (State endangered - *http://web4.msue.msu.edu/mnfi/abstracts/botany/Ranunculus_rhomboideus.pdf*), sand grass (State threatened) and purple milkweed (State species of special concern - *http://web4.msue.msu.edu/mnfi/abstracts/botany/Asclepias_purpurascens.pdf*)[123135]. Cooper's Hawk (State species of special concern - *http://web4.msue.msu.edu/mnfi/abstracts/zoology/Accipiter_cooperii.pdf*) is also found in lakeplain oak opening.

IV. A. 6. Evergreen forest

Within the C-CAP classification scheme, evergreen forest consists of lands with over 20 percent tree cover consisting mostly of species which retain their leaves or needles year-round. Historically, there were no native upland evergreen forests within the project area. Lands within the project area that are identified as evergreen forest by C-CAP satellite data are most likely pine plantations, Christmas tree farms or densely landscaped residential areas. Today, land classified as evergreen forest occupies almost 6000 acres (2,428 hectares) within the project area, with little change in the last few years.

IV. A. 7. Mixed forest

According to the C-CAP classification scheme, mixed forests are lands with over 20 percent tree cover, with both deciduous and evergreen species present but with less than 75 percent coverage by either type. Historically, no native upland mixed deciduous / evergreen forests were noted, and those identified as mixed forest by C-CAP satellite data probably consist of degraded forest which has been invaded by pines, or densely planted developed areas. About 2,700 acres (1,092 hectares) of mixed forest occur within the project area, and reflect little change between 1995 and 2000.

IV. A. 8. Scrub/shrub

According to C-CAP, scrub/ shrub lands are areas dominated by shrubs and small trees that are less than five meters tall. The shrub canopy is usually greater than 20 percent of the total vegetation. This may represent a successional stage between old field and forest or trees may be stunted because of harsh environmental conditions[136]. Within the project area there are 3,753 acres (1,519 hectares) of scrub/shrub lands, which make up less than 1 percent of the total area[137].

Typically, scrub/shrub lands are old fields that are gradually reverting to forest, and contain many of the herbaceous species found earlier in the description of cultural grasslands and old fields, such as smooth brome, goldenrod, Queen Anne's lace and chicory. Typical shrubs include natives such as gray dogwood, blackberry, red raspberry, northern dewberry, hazelnut and staghorn sumac and introduced species such as common buckthorn, autumn olive and honeysuckle. Trees that gradually begin to appear include hawthorn, crabapple, quaking aspen, red maple and oaks[138].

Common bird species that utilize scrub/shrub lands include rufous-sided towhee, blue-winged warbler, yellow warbler, gray catbird, chipping sparrow, field sparrow and song sparrow[139].

IV. A. 9. Bare Land

According to C-CAP, bare lands can occur on rock, sand or clay substrate. They can range from natural settings, such as bedrock, desert pavement, volcanic material, glacial debris and sand dunes, to man-made features such as gravel pits and strip mines. In any case, vegetation covers less than ten percent of the land[140]. Within the project area, a few sand or gravel pits may fall into this category but the majority of these lands consist of sites which are being cleared for construction. They provide little habitat, and be a significant source of soil erosion and sedimentation. Bare lands increased from 1,723 acres (697 hectares) in 1995 to 2,163 acres (875 hectares) in 2000, an increase of 25 percent.

IV. B. Wetlands and deepwater habitat

According to Cowardin et al.[141], "wetlands are lands where saturation with water is the dominant factor determining soil development and the types of plant and animal communities living in the soil and on its surface." While there are a number of different systems for classifying wetlands, three criteria are common to most of them; wetlands have saturated soils or are flooded for at least part of the year; wetlands often have soil conditions that are different from those in the adjacent uplands; and wetlands contain plants which are adapted to flooding[142]. C-CAP classifies all freshwater wetlands as palustrine, including aquatic beds, emergent wetlands, scrub/shrub wetlands and forested wetlands. In some cases, natural communities which function as an integrated system may be split into two different categories, as the emergent zone of marshes for example, fall into the palustrine emergent category and their submergent zone is categorized as aquatic bed[143]. Other systems of classification include additional freshwater categories for riverine and lacustrine wetlands for systems which are associated with rivers or lakes[144]. As mentioned earlier, headings such as "Palustrine Emergent Wetland" are actual CCAP land cover types, while subheadings within them such as "Lacustrine Aquatic Bed" or "Riverine Open Water" are specific natural communities.

HIGHLIGHT

"Wetlands are lands where saturation with water is the dominant factor determining soil development and the types of plant and animal communities living in the soil and on its surface."

Cowardin et al.

Prior to European settlement, the entire periphery of Lake St. Clair was surrounded by wetlands, including emergent marsh along the shoreline and wet prairies, meadows and swamps further inland. In deeper water, wild celery beds were an important source of food for migrating waterfowl. Because the land was fertile and the climate moderated by the lake, it was quickly settled and cleared for farming. Large scale drainage began in the mid nineteenth century. In 1873, there were still 18,000 acres of coastal wetland around Lake St. Clair on the Michigan shore but by 1973, only 5,000 of them remained[145]. On the Ontario shore of the lake, about 32,000 acres remained in 1978[146].

HIGHLIGHT

Prior to European settlement, the entire periphery of Lake St. Clair was surrounded by wetlands, including emergent marsh along the shoreline and wet prairies, meadows and swamps further inland.

Within the project area as a whole, C-CAP satellite data show about 51,000 acres of wetland, including forested wetlands. The majority of the lands are located around the northern end of Lake St. Clair. Between 1995 and 2000, about 42 acres were converted to developed or agricultural lands.

IV. B. 1. C-CAP land cover class: Unconsolidated shores

Unconsolidated shores are highly dynamic systems altered by changing lake levels, wave activity, sedimentation and erosion. They include beaches, bars and flats, and are regularly flooded and redistributed by the action of tides or currents. Because conditions are constantly changing, they generally do not have vegetation other than pioneer plants, which grow for brief periods of time[147]. Despite this lack of vegetation, these lands are valuable foraging grounds for avian species such as black-bellied plover and American golden-plover during the migration[148].

According to C-CAP satellite data there are only about 750 acres of unconsolidated shores within the project area and this amount shows little change.

FACT

Within the project area, palustrine emergent wetlands include the emergent zone of inland and Great Lakes marshes, wet meadows, lakeplain wet prairies and lakeplain wet-mesic prairies.

IV. B. 2. C-CAP land cover class: Palustrine emergent wetlands

Palustrine emergent wetlands are characterized by rooted, upright, herbaceous plants, which are adapted to seasonally saturated or inundated soils and usually persist until the next growing season. Typically, at least 80 percent of their area is covered with plants and they are dominated by perennials. Within the project area, palustrine emergent wetlands include the emergent zone of inland and Great Lakes marshes, wet meadows, lakeplain wet prairies and lakeplain wet-mesic prairies[149, 150]. Although it is difficult to accurately assess wetland area as it expands and contracts as water levels go up and down, according to the most recent project data it occupies over 22,000 acres or about 3 percent of the total area[151].

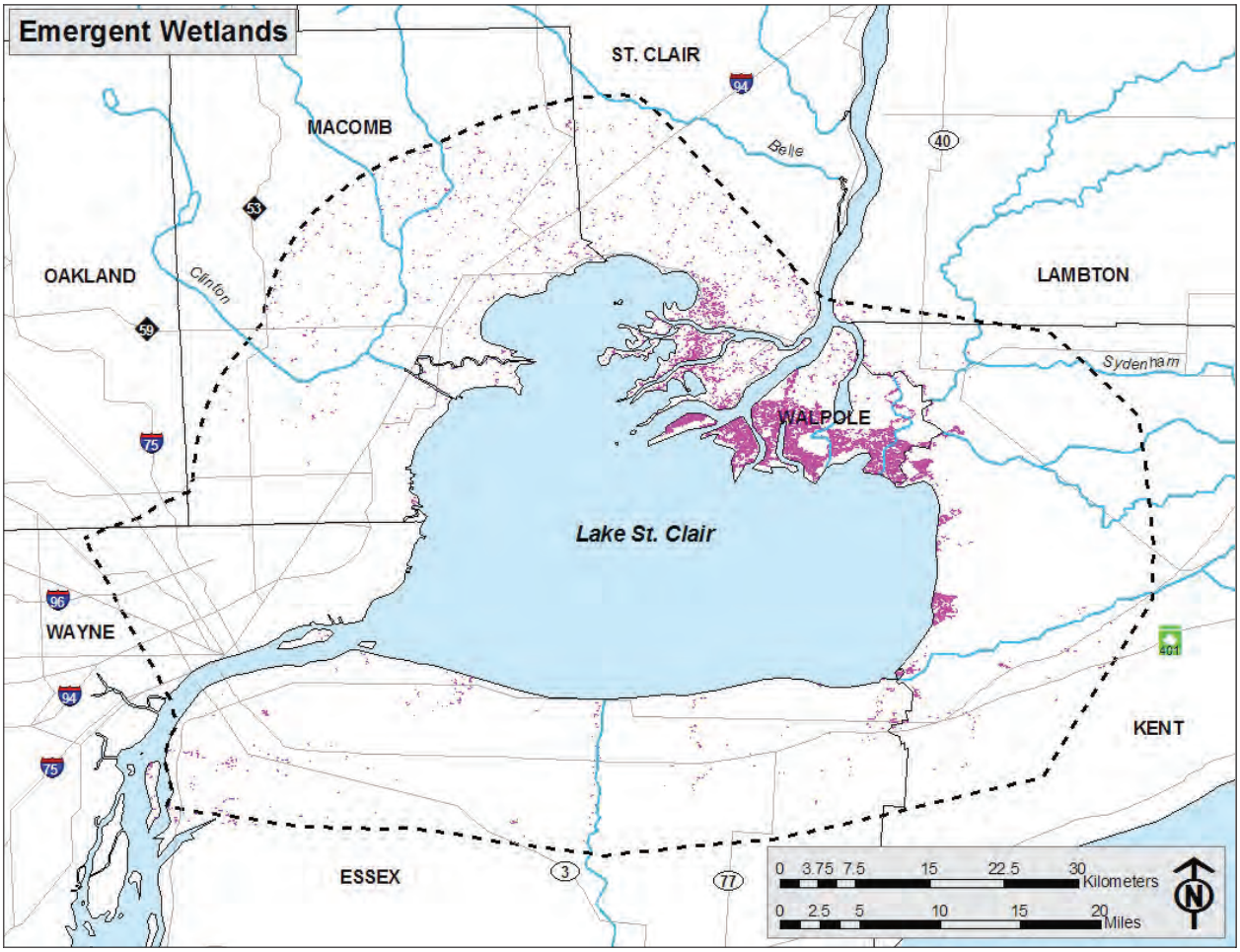


Figure IV B 2 - 1
Emergent wetlands

IV. B. 2. a. Inland marsh

Inland marshes are a common wetland type throughout Michigan, on poorly drained muck (organic) soils. They are often associated with streams or inland lakes and are characterized by an emergent zone, which may have saturated soils or shallow water and a submergent zone that tends to be permanently flooded, with water depths ranging between six inches and three or more feet during the growing season. Within the project area inland marshes are less common, occurring in shallow depressions in the lakeplain with poorly drained soils. Historically, they were found adjacent to

southern swamps, floodplain forest and lakeplain prairie or in scattered small depressions throughout the broader landscape. Inland marshes may also be associated with southern shrub-carr[152, 153].

Muskrat
Photo: John Schafers. MDNR

Marshes are highly productive systems with plentiful nutrients and circumneutral soils[154]. Bacteria are active in nitrogen fixation and rates of decomposition are relatively rapid. The accumulated organic layer is the result of high turnover rather than the slow decomposition that is characteristic of bogs. Peat may or may not accumulate[155]. Periodic exposure of the soils as water levels fall (drawdown) can be critical in providing the oxygen necessary for aerobic decomposition as standing water tends to be poorly oxygenated. Although many wetland plants are adapted to low oxygen availability, when anaerobic conditions persist, decomposition slows and partially decayed vegetation tends to accumulate. With drawdown, the dead plant materials are exposed to oxygen and aerobic decomposition proceeds at a much faster rate[156].

Inland marshes depend on both rainwater and runoff from surrounding lands and are heavily influenced by their drainage basins. In many areas, groundwater is also a significant source of water although this is less common in the lakeplain where groundwater flow is limited by the heavy clay soils. Inland marshes undergo characteristic cycles as water levels go up and down in response to drought or changes in the water table. During drought large areas of mudflats are exposed, triggering germination of the seeds of emergents that spread while the soil is exposed. As the water levels rise annuals are flooded out but perennials persist. Over time, muskrats eat the emergents, creating patches of open water, which are utilized by a variety of waterfowl. During the next period of drought, mudflats are once again exposed and the cycle continues[157, 158, 159].

FACT
Inland marshes depend on both rainwater and runoff from surrounding lands and are heavily influenced by their drainage basins.

In the emergent zone, plants like arrowhead, pickerel weed, sedges and cattail are typical along the shoreline in shallow water and in the submergent zone, in deeper water, submerged and floating leaved plants like wild celery, pondweed, duckweed, yellow pond lily and sweet-scented water lily are characteristic[160]. Invasive species such as common reed and purple loosestrife are an increasing problem and will be discussed later (see section III. M. Invasive species).

Inland marshes are among the most productive wetlands for waterfowl, shorebirds and furbearers such as the muskrat and also provide spawning and nursery habitat for some fish if the water is deep enough. The abundant insects found there provide food for fish, amphibians, reptiles and birds, while the dense vegetation serves as cover. Marshes that are connected to lakes or rivers can serve as spawning grounds and nurseries for fish species such as northern pike and largemouth bass. Common mammalian residents include muskrat, mink and raccoon. Eastern cottontail and deer often feed in marshes. In addition to waterfowl, other avian species that utilize inland marshes include greater and lesser yellowlegs, red-winged blackbird and black tern.

Rare animals found in inland marshes include black-crowned night heron (State threatened - *http://web4.msue.msu.edu/mnfi/abstracts/zoology/Nycticorax_nycticorax.pdf*), king rail (State threatened - *http://web4.msue.msu.edu/mnfi/abstracts/zoology/Rallus_elegans.pdf*), northern harrier (State species of special concern - *http://web4.msue.msu.edu/mnfi/abstracts/zoology/Circus_cyaneus.pdf*), Forster's tern (State species of special concern - *http://web4.msue.msu.edu/mnfi/abstracts/zoology/Sterna_forsteri.pdf*), spotted turtle (Threatened - *http://web4.msue.msu.edu/mnfi/abstracts/zoology/Clemmys_guttata.pdf*) and Blanding's turtle (Species of special concern - *http://web4.msue.msu.edu/mnfi/abstracts/zoology/Emys_blandingii.pdf*). Rare plants include lake cress (State threatened), yellow nut-grass (state species of special concern), spearwort (State threatened - *http://web4.msue.msu.edu/mnfi/abstracts/botany/Ranunculus_ambigens.pdf*) and wild rice (State threatened - *http://web4.msue.msu.edu/mnfi/abstracts/botany/Zizania_aquatica_var_aquatica.pdf*)[161].

Blanding's Turtle

IV. B. 2. b. Lakeplain wet prairie & lakeplain wet-mesic prairie

Lakeplain prairie was initially introduced in the upland section. While mesic sand lakeplain prairie is an upland form of prairie, lakeplain wet prairie (*http://web4.msue.msu.edu/mnfi/abstracts/ecology/Lakeplain_wet_prairie.pdf*) and lakeplain wet-mesic prairie (*http://web4.msue.msu.edu/mnfi/abstracts/ecology/Lakeplain_wet-mesic_prairie.pdf*) both appear with the C-CAP classification scheme as emergent wetland. Natural disturbance regimes including fire and seasonal flooding, which were discussed earlier in the upland section, are also critical to the survival of each of these prairie types. Lakeplain wet prairie occupies the wettest end of the spectrum, occurring on sand lakeplain and on deposits of dune sand within the clay lakeplain. It is generally found close to the shore, between Great Lakes marsh, and lakeplain wet-mesic prairie. Soils consist of poorly drained medium sands, to silty clay loams and can be somewhat alkaline, ranging from a pH of 7.0 to 8.0. Water levels fluctuate both seasonally and annually. Lakeplain wet-mesic prairie is a bit dryer than lakeplain wet prairie and is generally found further inland, on sand lakeplain with soils that can range from a pH of 6.0 to 8.0. Typically, it is flooded in spring and experiences drought conditions in summer and fall, although it can contain patches that remain moist throughout the growing season[162, 163]. Although most wet and wet mesic lakeplain prairie was drained and farmed in the 1800s, sizable high-quality remnants still exist within the St. Clair Delta on both the U.S. and Walpole Island First Nation portions. Additional large remnants survive within the project area in Algonac State Park and in the Ojibway Prairie Complex in Windsor. As in the case of lakeplain mesic sand prairie, management includes using prescriptive fire, controlling

Pottowatomi Prairie, Walpole Island First Nation

HIGHLIGHT

Although most wet lakeplain prairie was drained and farmed in the 1800s, sizable high-quality remnants still exist within the St. Clair Delta on both the U.S. and Walpole Island First Nation portions.

invasive species such as sweet white clover, spotted knapweed, purple loosestrife and common reed and restoring the original hydrology of the site whenever possible.

Lakeplain wet prairie and lakeplain wet-mesic prairie have many features in common with each other and with lakeplain mesic sand prairie (see section II. C. 1. d. 2. Lakeplain mesic sand prairie). With their tall grasses and flowers, they resemble upland grassland more than a typical wetland, such as a marsh. They are distinguished from other sorts of lakeplain prairie by the presence of wet prairie grasses such as blue-joint grass and prairie cordgrass, rush, twig-rush, and sedges. In the more mesic forms, big bluestem, little bluestem, Indian grass, and switchgrass are common. Typical wildflowers include swamp milkweed, blue flag, Canada anemone, bushy aster and whorled loosestrife in the wetter areas and Virginia mountain mint, dense blazing star, Ohio goldenrod, tall coreopsis, colic root, tall sunflower, black-eyed Susan and grass-leaved goldenrod elsewhere. Lakeplain prairies are among the most diverse plant communities in the project area, with up to 200 species occurring at a single site.

HIGHLIGHT

Lakeplain prairies are among the most diverse plant communities in Michigan, with up to 200 species occurring at a single site.

Common wildlife species that utilize wet prairies include mallard and blue-winged teal, frogs, turtles, northern water snake, crayfish and a number of furbearers, including muskrat, raccoon, mink and weasel. Within the prairie, enormous ant mounds and crayfish chimneys are hidden by the tall grasses. Historically, bison and elk utilized prairies as habitat but the only remaining ungulate is the white-tailed deer, which feeds along the prairie edge.

Rare plant species include three-awned grass (State threatened - *http://web4.msue.msu.edu/mnfi/abstracts/botany/Aristida_longespica.pdf*), short-fruited rush (State threatened - *http://web4.msue.msu.edu/mnfi/abstracts/botany/Juncus_brachycarpus.pdf*), Leiberg's panic grass(State threatened - *http://web4.msue.msu.edu/mnfi/abstracts/botany/Panicum_leibergii.pdf*), yellow nutgrass (State species of special concern), seedbox (State threatened), chestnut sedge (State threatened - *http://web4.msue.msu.edu/mnfi/abstracts/botany/Fimbristylis_puberula.pdf*), cross-leaved milkwort (State threatened), pink milkwort (extirpated in Michigan, federally listed in Canada - *http://web4.msue.msu.edu/mnfi/abstracts/botany/Polygala_incarnata.pdf*), Clinton's bulrush (State species of special concern), northern appressed clubmoss (State species of special concern - *http://web4.msue.msu.edu/mnfi/abstracts/botany/Lycopodiella_subappressa.pdf*), purple milkweed (State spe-

Eastern fox snake
Photo: John Schafers. MDNR

cies of special concern - *http://web4.msue.msu.edu/mnfi/abstracts/botany/Asclepias_purpurascens.pdf*), eastern prairie fringed orchid (Federally listed as threatened - *http://web4.msue.msu.edu/mnfi/abstracts/botany/Platanthera_leucophaea.pdf*), white lady's-slipper orchid (State threatened - *http://web4.msue.msu.edu/mnfi/abstracts/botany/Cypripedium_candidum.pdf*), Gattinger's gerardia (State endangered), Skinner's gerardia (State endangered - *http://web4.msue.msu.edu/mnfi/abstracts/botany/Agalinis_gattingeri.pdf*) and Sullivant's milkweed (State threatened - *http://web4.msue.msu.edu/mnfi/abstracts/botany/Asclepias_sullivantii.pdf*)[164, 165, 166].

A number of rare animals are found in the wetland lakeplain prairie types, including eastern fox snake (State threatened - *http://web4.msue.msu.edu/mnfi/abstracts/zoology/Elaphe_vulpina_gloydi.pdf*), spotted turtle (State threatened - *http://web4.msue.msu.edu/mnfi/abstracts/zoology/Clemmys_guttata.pdf*) and Blanding's turtle (State species of special concern - *http://web4.msue.msu.edu/mnfi/abstracts/zoology/Emys_blandingii.pdf*). Rare birds that nest in lakeplain prairie include least bittern (State threatened - *http://web4.msue.msu.edu/mnfi/abstracts/zoology/Ixobrychus_exilis.pdf*) and king rail (State endangered - *http://web4.msue.msu.edu/mnfi/abstracts/zoology/Rallus_elegans.pdf*). Rare insects such as red-legged spittlebug (State species of special concern - *http://web4.msue.msu.edu/mnfi/abstracts/zoology/Prosapia_ignipectus.pdf*), wild indigo dusky wing (State species of special concern), Culver's root borer (State species of special concern - *http://web4.msue.msu.edu/mnfi/abstracts/zoology/Papaipema_sciata.pdf*), blazing star borer (State species of special concern - *http://web4.msue.msu.edu/mnfi/abstracts/zoology/Papaipema_beeriana.pdf*) and silphium borer moth (State threatened - *http://web4.msue.msu.edu/mnfi/abstracts/zoology/Papaipema_silphii.pdf*) are intimately tied to host plants that are found only in high quality prairie[167]. Historically, the eastern massasauga (state species of special concern - *http://web4.msue.msu.edu/mnfi/abstracts/zoology/Sistrurus_catenatus.pdf*) was also known to occur in these wet grasslands, particularly on Walpole Island and Belle Isle.

IV. B. 2. c. Great Lakes marsh

Great Lakes Marshes (*http://web4.msue.msu.edu/mnfi/abstracts/ecology/Great_lakes_marsh.pdf*) are extremely diverse and productive wetlands that are found along the Great Lakes shoreline. They generally occur as part of a wetland complex that includes submergent and emergent marsh, mudflats, wet meadows and shrub swamps[168, 169]. They differ from inland marshes in several significant ways; their water levels are tied to those of the Great Lakes; they are subject to large short term variations in water level caused by wind or barometric pressure, their substrates are mineral as organic materials are flushed out by currents, oxygen levels are higher, they tend to have a more gradual shoreline, which results in greater zonation; and shoreline erosion and sediment re-deposition are greater because of the influence of wind, wave action and ice scour[170, 171].

Historically, Lake St. Clair was surrounded by Great Lakes Marsh but much of that marsh has been filled in. On the Michigan side of the lake shoreline development has been extensive while on the Canadian side, agricultural uses predominate. Sizable remnants remain on the St. Clair Delta, including St. John's Marsh, and Dickinson Island in Michigan and on Walpole Island First Nation on the Canadian side of the lake. Smaller remnants also persist, including the St. Clair Marshes complex in Mitchell's Bay, Ruscom Shores marsh and the Thames River marsh on the Canadian side of the lake and in Anchor Bay and at the mouth of the Clinton River on the U.S. side[172].

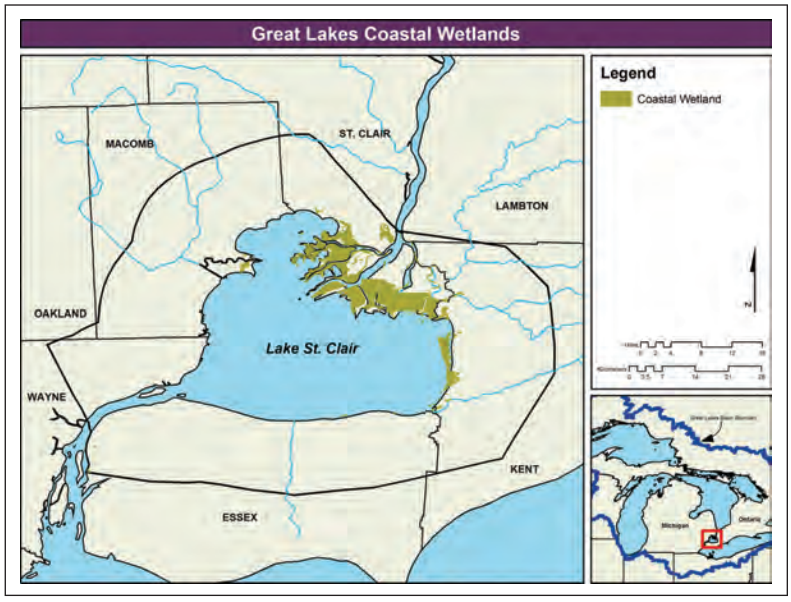


Figure IV B 2 c - 1
Great Lakes coastal wetlands

Fluctuations in water levels are characteristic of Great Lakes Marshes and have a huge influence on them. Historically, water levels in Lake St. Clair have varied between years within a 2.08 meter range[173-174]. These fluctuations in lake levels affect not only water depth at a given location but a broad range of other factors, including wave energy, turbidity, changes in current, light availability, nutrients, temperature, ice scour and sediment deposition. (More detailed information about Lake St. Clair water levels is found in Section III. C. on hydrology.)

Great Lakes Marsh on Walpole Island First Nation
Photo: Laura Lodisio, USEPA

Coastal systems are adapted to periodic inundation and require it to maintain high levels of biodiversity. Diking and shoreline hardening disrupt natural cycling by favoring species which cannot tolerate water level changes and exclude species which need exposed fertile soils for germination, reducing overall species diversity. While some wetland species are broadly adapted, most prefer a narrow range of environmental conditions. This factor, in conjunction with the shallow slopes of Lake St. Clair's shorelines, results in diverse patterns of species composition within a given vegetative zone. At the same time, these zones are rarely fixed in space. As relatively small increases or decreases in water level can inundate or uncover large areas of land on the shallow gradient, the different zones move in and out with the interannual changes in water level[175, 176].

FACT
Coastal systems are adapted to periodic inundation and require it to maintain high levels of biodiversity. Diking and shoreline hardening disrupt natural cycling by excluding species which need exposed fertile soils for germination, reducing overall species diversity.

The submergent and emergent zones in Great Lakes Marsh in the project area contain many of the same species as are found in inland marshes: submerged and floating leaved plants like wild celery, pondweed, duckweed and water lilies in the submergent zone and arrowhead, pickerel weed, sedges and cattail in the emergent zone[177, 178]. Species in the wet meadows include bluejoint grass, spike rush, lake sedge, tussock sedge, blue flag, swamp milkweed and fowl meadow grass. Invasive species such as common reed and purple loosestrife are an increasing problem and will be discussed later (see section V. E. Invasive species).

During periods of high water, the emergents are flooded out and floating leaved and submergent plants expand their range as they are more tolerant of flooding. Further inland, as flooding increases, emergents replace wet meadow and wet meadow expands into shrub/carr as the shrubs are inundated and die. As water levels drop, communities move lakeward and fertile mud flats are exposed and recolonized by emergents from the seedbank[179].

Great blue heron
Photo: Don Breneman

The diverse coastal wetland communities within Lake St. Clair provide habitat for a wide range of organisms: invertebrate production is higher in marshes than open water; marshes function as spawning grounds and nursery cover for fish; an incredible variety of birds utilize the marshes for feeding, nesting, and foraging during the migration. Marshes around Lake St. Clair also provide nesting and/or foraging grounds for great blue heron (*http://web4.msue.msu.edu/mnfi/abstracts/zoology/Great_Blue_Heron_Rookery.pdf*), black crowned night heron (*http://web4.msue.msu.edu/mnfi/abstracts/zoology/Nycticorax_nycticorax.pdf*), American bittern (*http://web4.msue.msu.edu/mnfi/abstracts/zoology/Botaurus_lentiginosus.pdf*), least bittern (State threatened - *http://web4.msue.msu.edu/mnfi/abstracts/zoology/Ixobrychus_exilis.pdf*), black tern (*http://web4.msue.msu.edu/mnfi/abstracts/zoology/Chlidonias_niger.pdf*), king rail (State endangered - *http://web4.msue.msu.edu/mnfi/abstracts/zoology/Rallus_elegans.pdf*) and northern harrier (State threatened - *http://web4.msue.msu.edu/mnfi/abstracts/zoology/Circus_cyaneus.pdf*)[180].

The St. Clair River Delta is one of the most critical areas for waterfowl breeding and staging during the migration in the entire Great Lakes Region. Waterfowl that breed in the St. Clair Delta include dabbling ducks; mallard, black duck, and blue-winged teal and one diving duck species--redhead. Far more species of waterfowl use the delta during the migration, as it is located on both the Atlantic Flyway and the Mississippi Flyway. Over 800,000 ducks pass through the area annually. Diving ducks such as canvasback, redhead and scaup feed on the wild celery, waterweed and pondweed of the submergent marsh, before heading southeastward to the Chesapeake Bay, although up to 15,000 overwinter on Belle Isle and the Detroit River. Dabbling ducks such as green-winged teal, northern shoveler and northern pintail feed on the eelgrass, widgeon grass and seeds of sedges, bulrushes, wild rice, pondweeds and smartweeds. The area is a major staging ground for tundra swan and migratory Canada geese, as well[181, 182].

HIGHLIGHT

The St. Clair River Delta is one of the most critical areas for waterfowl breeding and staging during the migration in the entire Great Lakes Region.

Lake St. Clair marshes provide valuable habitat for over 65 species of fish, either permanently, or on a temporary basis for spawning, nursery areas, shelter or feeding. Permanent residents include rock bass, bluegill, bullheads, channel catfish and white perch. A number of gamefish use the area also; northern pike, muskellunge, which spawns in the delta wetlands, walleye, yellow perch, smallmouth bass and crappie. Thirty-nine species of amphibians and reptiles use Lake St. Clair's marshes including salamanders, frogs, toads, turtles and snakes. Common mammals include muskrat, mink, raccoon, opossum and red fox[183, 184].

Rare birds that nest or forage in the marshes around Lake St. Clair include king rail (State endangered - *http://web4.msue.msu.edu/mnfi/abstracts/zoology/Rallus_elegans.pdf*), least bittern (State threatened - *http://web4.msue.msu.edu/mnfi/abstracts/zoology/Ixobrychus_exilis.pdf*), black-crowned night heron (State species of special concern - *http://web4.msue.msu.edu/mnfi/abstracts/zoology/Nycticorax_nycticorax.pdf*), common tern (State threatened - *http://web4.msue.msu.edu/mnfi/abstracts/zoology/Sterna_hirundo.pdf*), Forster's tern (State species of special concern - *http://web4.msue.msu.edu/mnfi/abstracts/zoology/Sterna_forsteri.pdf*), bald eagle (Federally listed as threatened, State threatened), northern harrier (State threatened - *http://web4.msue.msu.edu/mnfi/abstracts/zoology/Circus_cyaneus.pdf*), marsh wren (State species of special concern) and Louisiana waterthrush (State species of special concern). Rare reptiles include Blanding's turtle (State species of special concern - *http://web4.msue.msu.edu/mnfi/abstracts/zoology/Emys_blandingii.pdf*) and eastern fox snake (State threatened - *http://web4.msue.msu.edu/mnfi/abstracts/zoology/Elaphe_vulpina_gloydi.pdf*) and rare fish include northern madtom (State endangered - *http://web4.msue.msu.edu/mnfi/abstracts/aquatics/Noturus_stigmosus.pdf*), pugnose shiner (State species of special concern - *http://web4.msue.msu.edu/mnfi/abstracts/aquatics/Notropis_anogenus.pdf*) and pugnose minnow (State endangered - *http://web4.msue.msu.edu/mnfi/abstracts/aquatics/Opsopoeodus_emiliae.pdf*). Rare plants associated with the marshes include swamp rose mallow (State species of special concern) and wild rice (State threatened - *http://web4.msue.msu.edu/mnfi/abstracts/botany/Zizania_aquatica_var_aquatica.pdf*)[185, 186, 187].

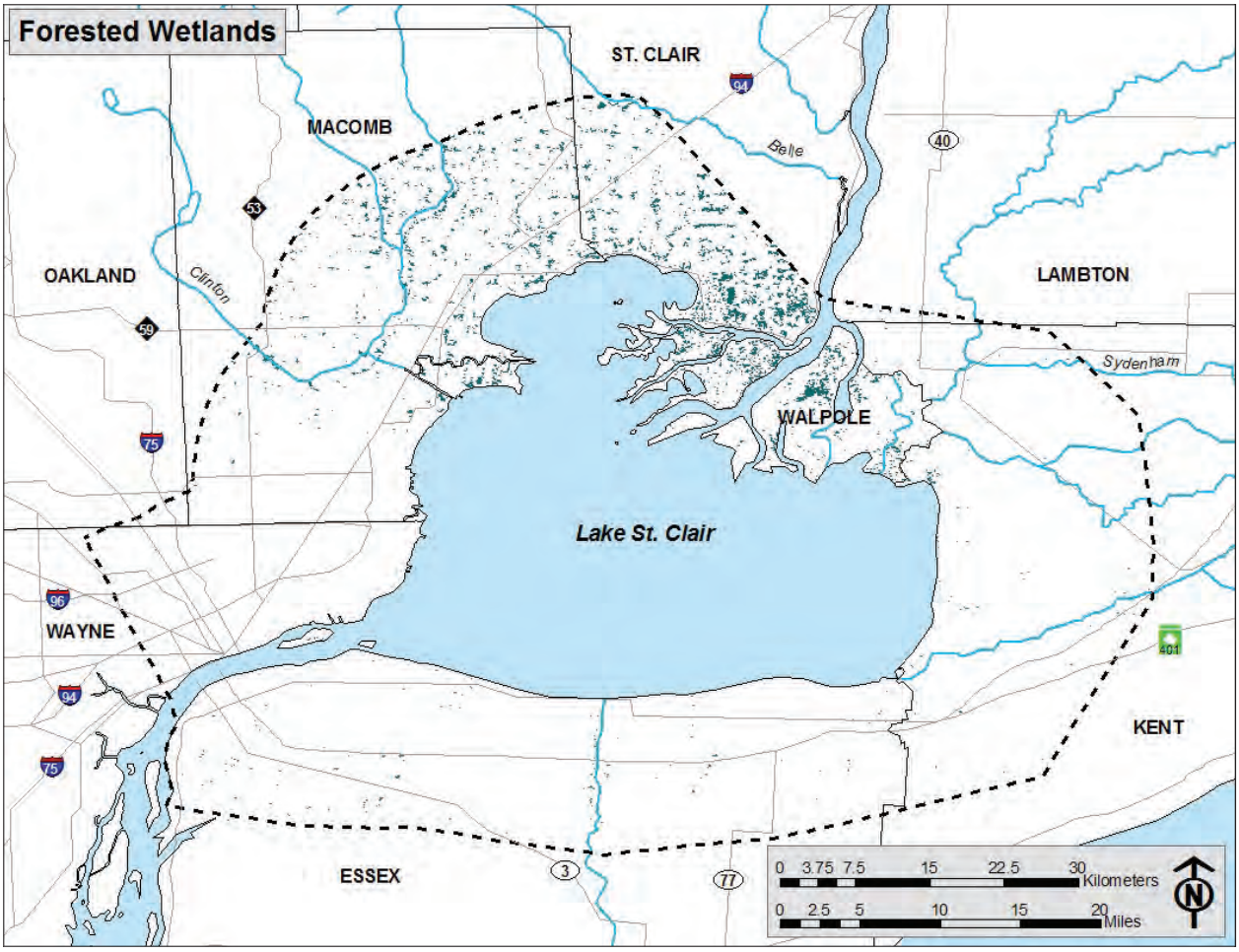


Figure IV B 3 - 1
Forested Wetlands

IV. B. 3. C-CAP land cover class: Palustrine forested wetlands

Palustrine forested wetlands include southern swamps and southern floodplain forests[188]. Historically, forested wetlands were common within the project area prior to the extensive logging of the nineteenth century. The flat, poorly drained soils, the thick clay layer underlying a thin layer of sand or loam and a high water table resulted in an abundance of lowland hardwood forest throughout the Maumee lakeplain[189]. Within the project area, wetland forest has declined from 17,113 acres to 16,686 acres between 1995 and 2000[190].

IV. B. 3. a. Southern swamp

Southern swamps are forested wetlands in isolated low areas with high water tables. Because they are not adjacent to rivers or streams, they do not experience flooding, although they may experience saturated soils and standing water in spring. Within the project area, they occur on low lying clay soils on the glacial lakeplain. Moisture and nutrients are generally available throughout the year but oxygen levels are low and the plants found there are adapted to these conditions. Swamps tend to have a high proportion of organic materials in their soils[191, 192].

Pin oak leaves and bark

Although nutrient levels are high, more mesic species such as sugar maple and American beech cannot invade because of the low levels of oxygen in spring. In prolonged periods of drought, they may gain a foothold but as wetter conditions return, they die off and are replaced by the black ash and red and silver maples, which can tolerate short periods of low oxygen. Windthrow is another important source of disturbance in southern swamps; trees tend to have shallow roots because of the high water table and heavy clays and as a result, are more easily uprooted during storms. The dead trees provide nest sites and dens for birds and small mammals, as well as habitat for invertebrates such as ants, termites and beetles[193]. In the resulting gaps, shade intolerant species such as ashes and oaks can regenerate.

Typical tree species in Southern swamps include black ash, red maple, silver maple and historically, American elm. The massive die-offs of elms caused by Dutch elm disease resulted in rising water tables in many swamps and this rise contributed to increased mortality in other species. Other species which are commonly found in swamps include swamp white oak, pin oak, blackgum and American hornbeam[194].

Spicebush berries

Southern swamps have a high proportion of vines, including poison ivy, wild yam, hog peanut, groundnut and wild grape. Common shrubs include buttonbush, spicebush, silky dogwood, common elderberry and nannyberry. In areas which are inundated in spring, wildflowers are sparse, but in slightly drier spots, a fairly rich spring flora can develop. Typical species include green dragon, wood phlox, bishop's cap, wild geranium, mayapple, sweet Cicely, black snakeroot and honewort. Sedges are particularly abundant and ferns such as sensitive fern, marsh fern and royal fern are common. Later in the season, Michigan lily, fringed loosestrife and spotted jewelweed are common[195].

Rare plants in southern swamps include showy orchis (State species of special concern - *http://web4.msue.msu.edu/mnfi/abstracts/botany/Galearis_spectabilis.pdf*), false hop sedge (State threatened), pumpkin ash (State threatened - *http://web4.msue.msu.edu/mnfi/abstracts/botany/Galearis_spectabilis.pdf*), Shumard oak (State species of special concern) and twinleaf (State species of special concern)[196]. The cerulean warbler (State species of special concern - *http://web4.msue.msu.edu/mnfi/abstracts/zoology/Dendroica_cerulea.pdf*), Indiana bat (Federally listed endangered, State endangered) and red-shouldered hawk (State threatened - *http://web4.msue.msu.edu/mnfi/abstracts/zoology/Buteo_lineatus.pdf*) are found here as well[197].

IV. B. 3. b. Southern floodplain forest

Southern floodplain forests are a deciduous forest type that occurs on mineral-rich soils along large streams or rivers, on the adjacent flats. In contrast with southern swamps, they are flooded each spring but dry out by midsummer. Soils are circumneutral loams or silt loams and are enriched by the layer of silt which accompanies each season's inundation[198].

HIGHLIGHT

Floodplain forests are among the most diverse plant communities in the state. Flooding, bank cutting and sediment deposition result in characteristic land forms.

Floodplain forests are among the most diverse plant communities in the state. The processes of flooding, bank cutting and sediment deposition result in characteristic land forms; sandbars and mudflats, levees or ridges along the water where coarser sediments are deposited and terraces behind the levees. The lowest terraces, which flood most frequently, have poorly drained clay or silty clay soils. The plants that occur here are adapted to extremely low oxygen levels. Higher terraces, which flood less frequently, have better drainage and levels of oxygenation. Patterns of species distribution follow the variations in micro-site conditions[199].

On recently deposited soils of sandbars and mudflats, fast-growing cottonwoods and willows are typical. Higher up, on the levee, swamp white oak, bur oak, shagbark hickory, American hornbeam and redbud are common. Behind the levee on the first terrace, silver maple and red ash are common as they can tolerate the extremely low oxygen levels that are present during flooding. American elm was formerly an important component of this community, prior to the advent of Dutch elm disease. On the second terrace where drainage is better, bur oak and shagbark hickory appear again and species such as red oak, white ash and tuliptree appear for the first time[200, 201].

In spring, cool air settles in the low river valleys where the water warms up slowly and as a result the trees do not leaf out until much later than higher areas nearby. Because of this, they are a refuge for more southern species which would suffer frost damage on the adjacent uplands, where temperatures rise earlier in spring but late frosts are common. Later in summer the floodplains are hotter and more humid than the uplands nearby. Southern species which reach their limit in Michigan's southern floodplain forest and Ontario's Carolinian Forest include honey locust, Ohio buckeye, paw-paw, redbud, blue ash, Kentucky coffee-tree, sycamore and hackberry[202].

FACT

Because of the flooding, fewer seedlings and saplings survive and as a result, floodplain forest tends to be more open, with very large trees.

In the southern mesic forest described earlier, in the absence of fire, shade tolerant species such as beeches and maples will eventually dominate, as less shade tolerant species cannot develop under their dense shade. On the floodplain, in contrast, the shallow-rooted trees are prone to frequent wind throw and upheaval during flood events. The resulting gaps are exploited by shade intolerant trees that continue to make up a permanent part of the community.

Because of the flooding, fewer seedlings and saplings survive and as a result, floodplain forest tends to be more open, with very large trees. Multi-stemmed trees are common. The understory in the lowest areas tends to have fewer plants also. As in southern swamps, vines such as poison ivy are common because they can cling to trees and rise above the flood waters. Moonseed, wild yam, wild grape and bittersweet are typical. Sedges, nettles and members of the carrot family are particularly well represented also. In the lowest areas there are few spring wildflowers because of the spring floods but green-headed coneflower, calico aster, purple Joe-Pye-weed and spotted jewelweed bloom later in the season. At slightly higher elevations where flooding is less severe, wild flowers such as green dragon, cut-leaf toothwort, yellow trout-lily and spring cress appear. Common floodplain shrubs include buttonbush, ninebark, American bladdernut, spicebush and prickly-ash[203].

Giant swallowtail on purple Joe-Pye-weed

The riparian corridor within southern floodplain forest can often provide vital linkages for wildlife, particularly in urban areas. White-tail deer, fox and coyote can travel along the river's edge and other mammals such as raccoon, opossum, muskrat, weasel, beaver, bats, squirrels, chipmunk and flying squirrel are typical. Small mammals, such as voles and shrews are common and provide a valuable food source for numerous carnivores[204].

Floodplain forests are particularly rich in bird species because of water availability, specialized nesting habitats and the abundance of insects and other invertebrates along the river's edge. Insectivorous species such as eastern phoebe, great crested flycatcher, blue-gray gnatcatcher, rough-winged swallow, northern oriole and warbling vireo are often found here[205]. Wood duck utilize cavities in trees along the river and mallards and American black duck are also typical.

Rare plants found in floodplain forest include cup-plant (Threatened), Virginia water horehound (Threatened), twin-leaf (State species of special concern), showy orchis (State species of special concern - *http://web4.msue.msu.edu/mnfi/abstracts/zoology/Buteo_lineatus.pdf*), false hop sedge (State threatened), red mulberry (Threatened), pumpkin ash (*http://web4.msue.msu.edu/mnfi/abstracts/zoology/Buteo_lineatus.pdf*), Shumard oak (State species of special concern) and wahoo (Species of special concern). The cerulean warbler (State species of special concern - *http://web4.msue.msu.edu/mnfi/abstracts/zoology/Dendroica_cerulea.pdf*), Louisiana water thrush (State species of special concern), Indiana bat (Federally listed endangered, State endangered) and red-shouldered hawk (State threatened - *http://web4.msue.msu.edu/mnfi/abstracts/zoology/Buteo_lineatus.pdf*) are also found here.

IV. B. 4. Palustrine scrub/shrub (Southern shrub carr)

Southern shrub carr is a shrub-dominated community which undergoes fluctuating water levels. It can occur along streams, rivers and lakes, typically in glacial outwash, ice contact topography, or end moraine. Soils are neutral to slightly alkaline muck, and retain moisture[206]. According to C-CAP satellite data, about 12,000 acres (4,856 hectares) of southern scrub carr remain[207]. Large tracts of forested and scrub-shrub wetlands probably occurred historically in the downstream areas of the Clinton River watershed[208].High-quality remnants still persist in the St. Clair Delta, in St. John's Marsh and on Walpole Island.

Within the southern shrub-carr, typical shrub species present include gray dogwood, silky dogwood, red-osier dogwood, elderberry, winterberry and buttonbush. Herbaceous species such as water plantain, blue-joint grass, swamp milkweed, marsh bellflower, marsh fern and boneset are also present. In much of the project area, this system has been

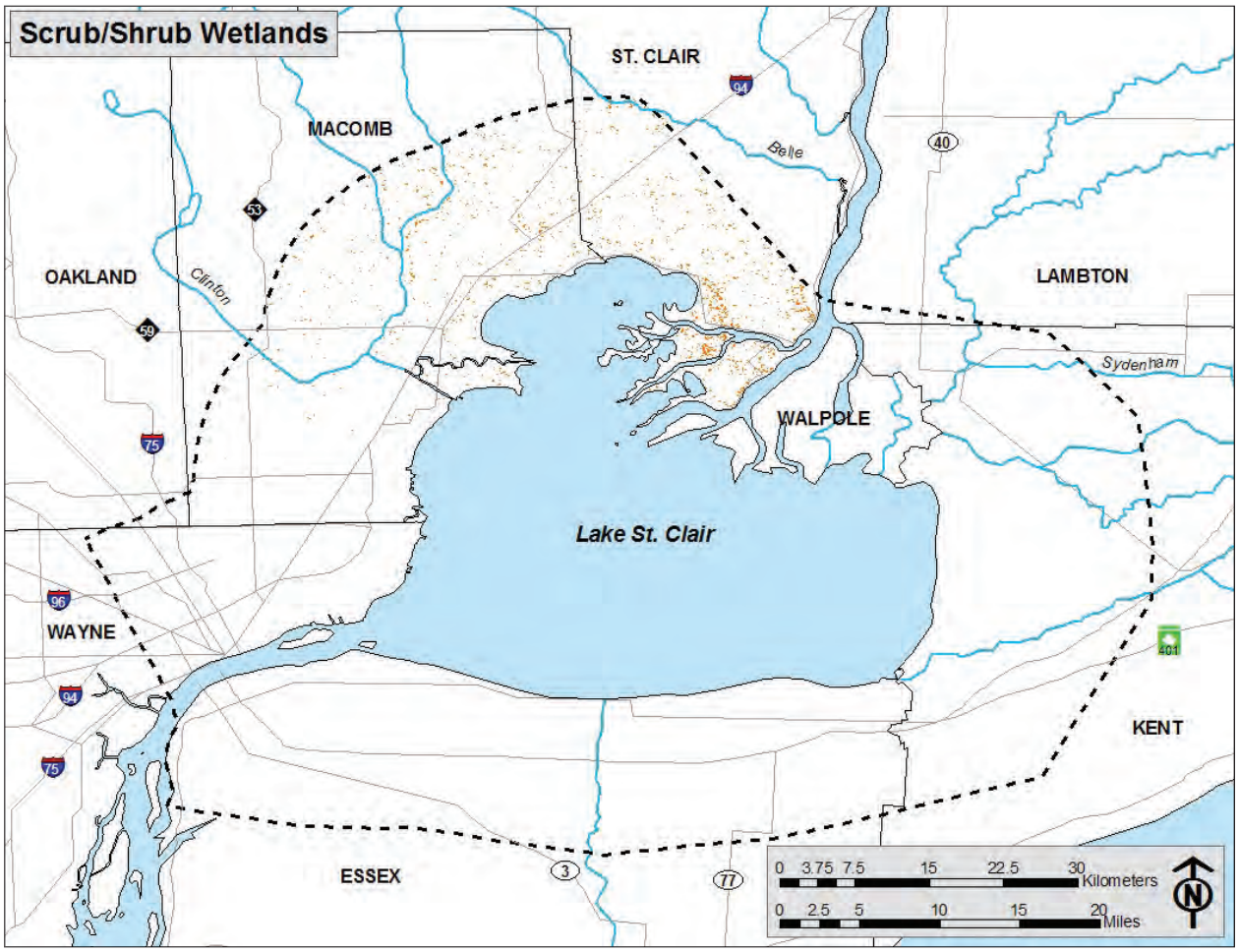


Figure IV B 4 - 1
Scrub/shrub wetlands

destroyed, as land was cleared nearly up to the water's edge for agriculture. A related community, the inundated shrub swamp is dominated by buttonbush and plants adapted to deeper water levels[209, 210].

Southern shrub carr provides habitat for furbearing mammals such as muskrats, mink, beaver and raccoons, as well as deer and rabbits. The shrubby vegetation provides valuable cover for songbirds such as song sparrow, swamp sparrow, marsh wren and yellow warbler. The northern copperbelly water snake (State Endangered and Federally Threatened) is also found here[211].

Buttonbush fruit

IV. B. 5. Open water

Within the C-CAP classification scheme open water consists of all areas of open water, generally with cover of less than 25 percent of vegetation or soil. Open water can occur as lakes (lacustrine), rivers (riverine), reservoirs, ponds, streams or oceans.

IV. B. 5. a. Lacustrine open water (basin > 8 hectares)

Lake St. Clair is productive and provides habitats for a diverse biota including invertebrates, fish, mammals, and waterfowl[212]. The historical fish communities in Lake St. Clair contained abundant lake sturgeon (*http://web4.msue.msu.edu/mnfi/abstracts/aquatics/Acipenser_fulvescens.pdf*) and runs of cold water fishes, including lake trout, lake whitefish, and lake herring that once supported commercial fishing in the lake[213]. Many of the native fishes have been eliminated by commercial fishing, habitat destruction, wetland losses, introduction of exotic fishes, invasion by exotic species, and degradation of water and substrate quality. Recent recreational fishing is primarily for yellow perch, walleye, smallmouth bass, muskellunge, white and freshwater drum.

HIGHLIGHT

The historical fish communities in Lake St. Clair contained abundant lake sturgeon and runs of coldwater fishes that once supported commercial fishing in the lake. Many of the native fishes have now been eliminated.

Recent survey data of fish from the MDNR were analyzed by the USGS Great Lakes Aquatic Gap project (Burke Greer, personal communication). Fish assemblages dominated by yellow perch, spottail shiner, and trout perch were found in the deeper open waters of the lake, in Anchor Bay (in a location downstream from the St. Clair delta and offshore from the Clinton River), and in the nearshore areas around the lake. Lake sturgeon dominated assemblages were found near the eastern outlets of the south and cut off channels where there are faster currents[214] and sandy substrates (Chris Marvin, Environment Canada, Burlington, Ontario, personal communication). Assemblages heavily dominated by invading round goby and endemic yellow perch were in shallower waters. Assemblages dominated by gizzard shad and mimic shiner were found at a variety of depths. Assemblages with a high percentage of shiners and mimic shiners as well as a diverse even mix of fish species were primarily in the nearshore areas.

The MDNR data on surveys of fish spawning throughout Lake St. Clair show that Lake St. Clair proper, its near shore areas and St. Clair flats are highly productive spawning areas. These spawning sites support fish communities and fish-

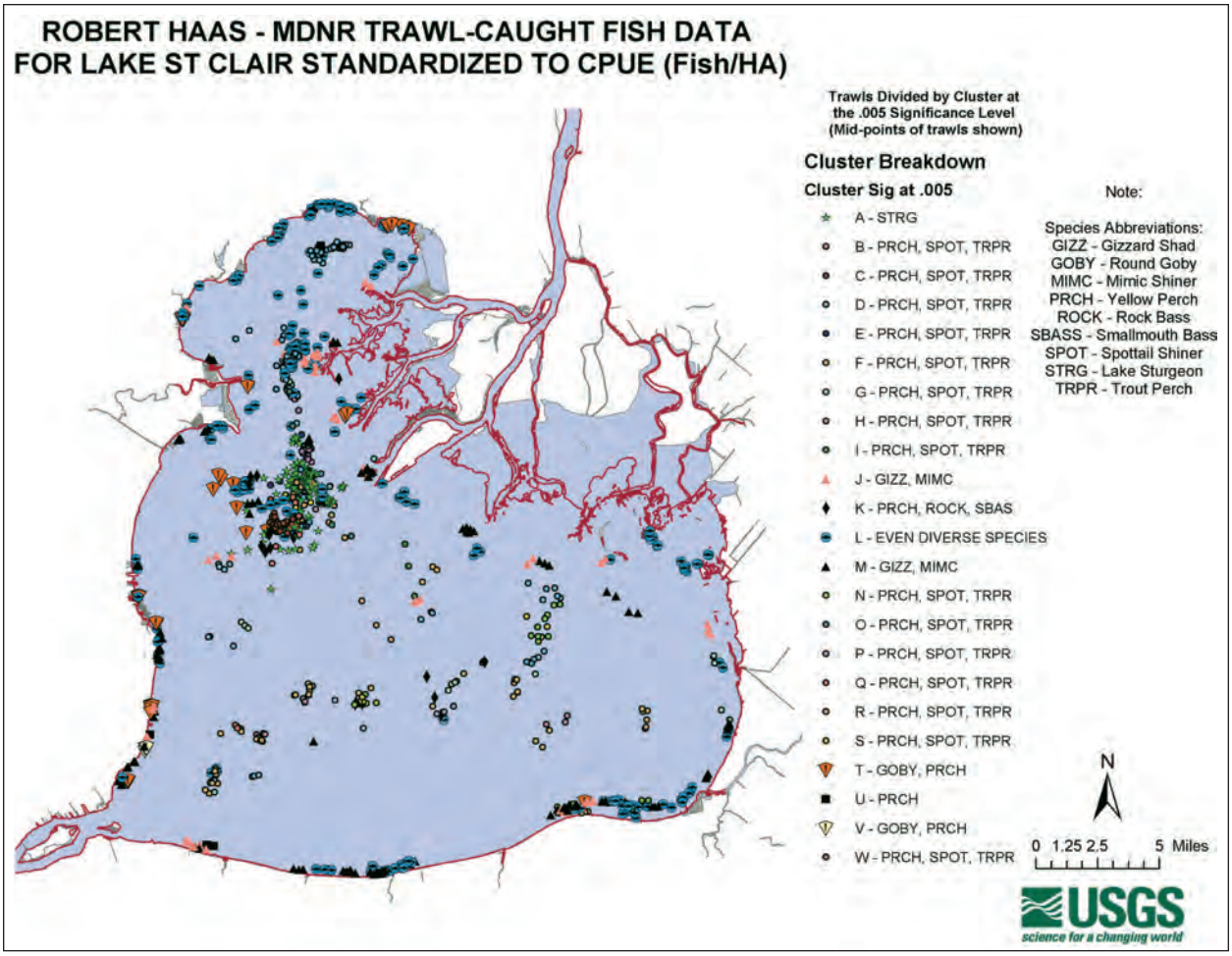


Figure IV B 5 a – 1
Fish Assemblages across Lake St Clair

eries in Lake Huron, Lake Erie, Lake St Clair, and in the St Clair and Detroit rivers. The MDNR data show thirty species spawning in the lower reaches of the St Clair River and the estuary-like St Clair flats region. Included are alewife, bluegill, carp, channel catfish, freshwater drum, gizzard shad, lake sturgeon, lake whitefish, largemouth bass, muskellunge, northern pike, smallmouth bass, walleye, white bass and yellow perch. Anchor Bay supports twenty-seven species at many spawning sites including alewife, blue gill, carp, channel cat, gizzard shad, lake sturgeon, largemouth bass, muskellunge, northern pike, smallmouth bass, walleye, and yellow perch. The nearshore areas of the eastern and western coastlines of Lake St Clair including the Clinton and Thames river mouths as well as other smaller tributaries are spawning grounds for twenty-five species including bluegill, carp, channel catfish, muskellunge, northern pike, white bass and yellow perch. The mouths of the Clinton and Thames rivers historically have also been spawning grounds for sea lamprey. The reason for their limited spread within Lake St Clair is due to lack of spawning habitat in the tributaries to Lake St Clair required for sea lamprey spawning. No fish spawning was observed in the offshore, deeper areas of the lake.

Surveys of zooplankton from different parts of Lake St. Clair showed that cladocerans or waterfleas, particularly bosminids, were the predominant group in both abundance and biomass. In other Great Lakes copepods are usually dominant. Lake St. Clair may be considered more typical cladoceran habitat because it is shallow, productive, and currently does not contain dense populations of plankton eating fish, such as lake herring, which previously occupied the lake. Zooplankton are important food for young fish.

The benthic macroinvertebrates of Lake St. Clair are diverse. A survey of 47 stations, which covered the entire lake and the lower St. Clair River, found 101 taxa of invertebrates. In general the system supports organisms associated with

relatively unpolluted waters[215]. Benthic invertebrates are a predominant component of food webs leading to fish for shallow waters.

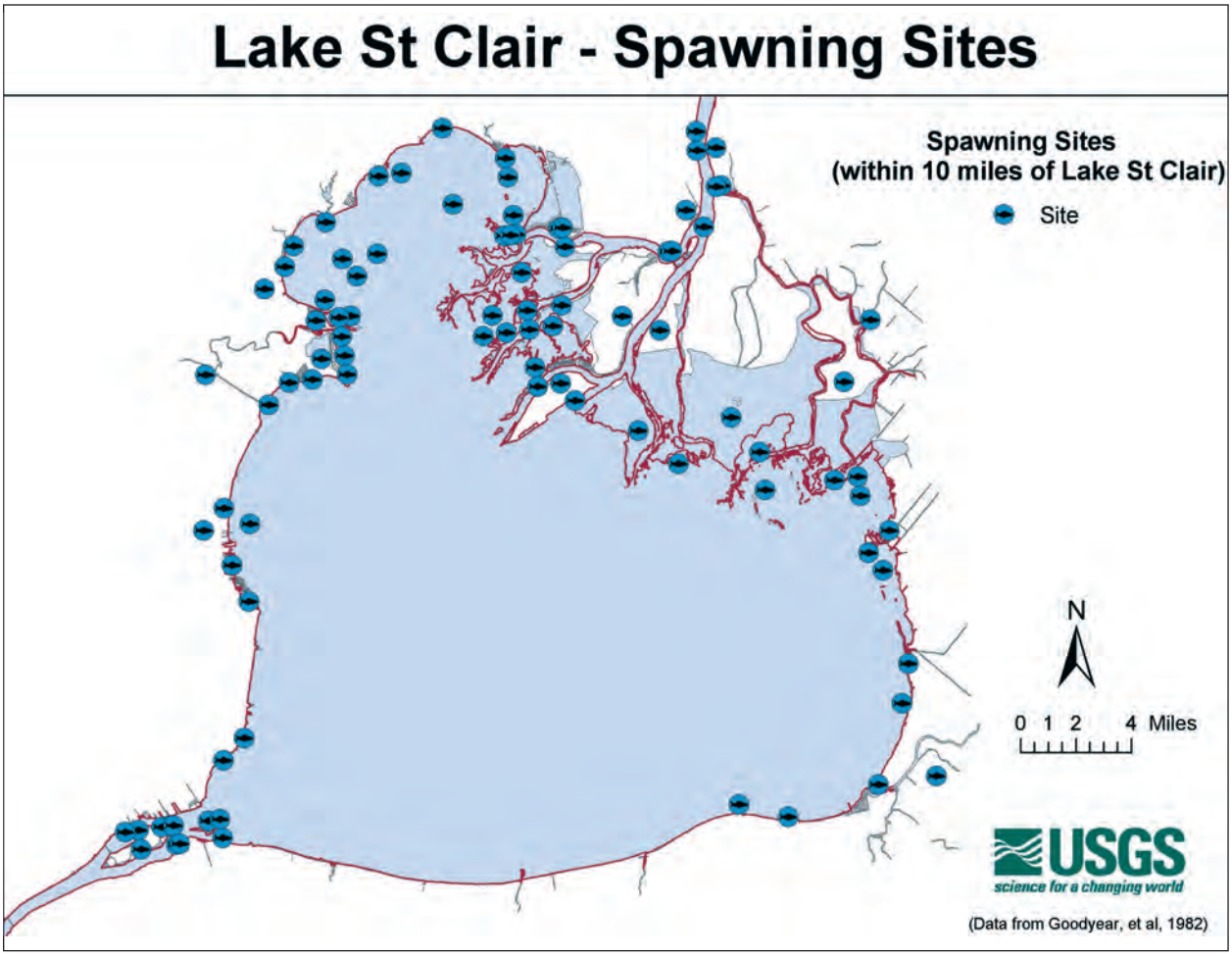


Figure IV B 5 a – 1
Fish Assemblages across Lake St Clair

IV. B. 5. b. Riverine open water

The Clinton River is the major watershed to Lake St. Clair on the American side of the lake. Historically, numerous high gradient reaches in the Clinton River provided excellent habitat for species such as smallmouth bass and served as spawning areas for potamodromous stocks of species such as sturgeon and walleye[216]. During surveys in 1990 and 1991, the Michigan Department of Natural Resources (MDNR) estimated that over 50% of the walleye population was contributed by stocked fingerlings. For the Clinton River watershed, the MDNR lists 52 species of fish in the database developed by the USGS Great Lakes Regional Aquatic Gap Analysis Project (Paul Steen, personal communication.). Some of the recreational fishes include brook trout, brown trout, rainbow trout, northern pike, largemouth bass, walleye, yellow perch, bluegill, black crappie, white crappie and bluegill. Other larger fish include carp, channel catfish, and golden redhorse. Other species of native lampreys, darters, dace, minnows, shiners, sculpins, and chubs are important in the Clinton River ecosystem.

HIGHLIGHT
Historically, numerous high gradient reaches in the Clinton River provided excellent habitat for species such as smallmouth bass and served as spawning areas for potamodromous stocks of species such as sturgeon and walleye.

The head of the Detroit river is also home to spawning for many of the already listed species especially lake sturgeon. Spawning grounds are thought to be around Peach Island. USGS has recently built lake sturgeon spawning habitat offshore from Belle Isle[217].

A survey of the Clinton River in 1977-1978 found 26 species of freshwater mussels, including four species on Michigan's rare and endangered species list. This number compares with 31 species found between 1870 to 1933[218]. Urban pollution has destroyed mussel habitat in parts of the river basin.

The Thames River in Ontario was designated a Canadian Heritage River in 2000. The Thames sustains one of the most diverse fish communities in Canada. The watershed's complex system provides a broad range of habitats for some 88 fish species. Walleye, longnose gar, bullheads, bass and Chinook salmon are just some of the species found here. Approximately 30 species of freshwater mussels are also recorded (*www.chrs.ca/Rivers/Thames/Thames-F_e.htm#2*).

GAP

Relatively few published current data on aquatic biota and habitat are available on Lake St. Clair and its tributaries.

The Sydenham River, a tributary in northwestern Lake St Clair, is found in the Mixedwood Plains Ecozone, the most diverse ecozone in Canada[219]. The aquatic community historically supported 80 fishes and 34 species of freshwater mussel. However, this river's diversity has declined. Fourteen aquatic species (8 fishes, 5 mussels, and 1 turtle) are designated as endangered, threatened by the Committee on the Status of Species at Rish in Canada (COSEWIC)[220]. Metcalfe and Smith reported that surveys between 1971 and 1991 suggested that the mussel communities were in decline. Only 13 to 26 of native species were still present[221].

Relatively few published current data on aquatic biota and habitat are available on Lake St. Clair and its tributaries. The delta area of the St. Clair River is included generally in the lacustrine sections of this report.

FACT

Aquatic Beds are characterized by plants that form a continuous layer on or at the water's surface.

IV. B. 6. Palustrine aquatic beds

Aquatic Beds are characterized by plants that form a continuous layer on or at the water's surface. They can include algal mats, detached floating mats and rooted plants which are submerged or have floating leaves, and at least 80 percent of their area is vegetated. Aquatic Beds can occur within inland and Great Lakes marshes where they are often referred to as the submergent zone. Aquatic Beds can also occur further out from the shore, where there is sufficient light to permit plant growth. The C-CAP classification scheme refers to all freshwater bodies of water as palustrine, but many wetland ecologists use the term palustrine to refer only to non-tidal bodies of water that are smaller than 8 hectares. Similarly, the terms riverine and lacustrine may be used to denote systems in rivers or lakes. While it may be confusing, the term Palustrine in this section's heading (IV. B. 6.) refers to the C-CAP land cover type, and the individual habitats described in the subsections below (IV. B. 6. a., b., & c.) are named to reflect their aquatic setting[222].

FACT

The C-CAP classification scheme refers to all freshwater bodies of water as palustrine, but many wetland ecologists use the term palustrine to refer only to non-tidal bodies of water that are smaller than 8 hectares.

IV. B. 6. a. Palustrine (proper) aquatic beds

Palustrine aquatic beds occur in ponds or non-tidal

bodies of water that are smaller than 8 hectares. They are characterized by plants that form a continuous layer on or at the water's surface. They can include algal mats, detached floating mats, and rooted plants, which are submerged, or have floating leaves. Again, at least 80 percent of their area is covered by some sort of vegetation. In marshes, aquatic beds are often referred to as the submergent zone, where they occur in association with emergent vegetation along the shoreline. Aquatic beds can also occur further out from the shore, where there is sufficient light to permit plant growth[223].

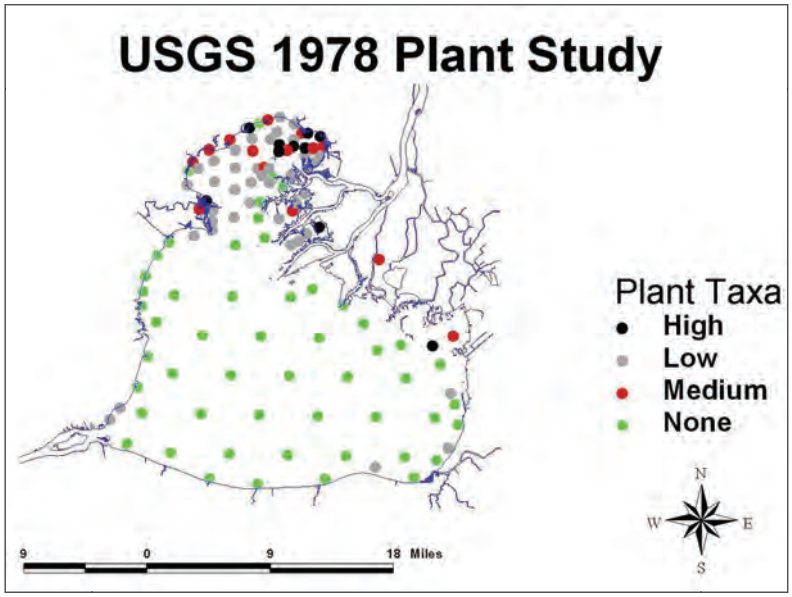


Figure IV B 6 b – 1
The distribution of aquatic vegetation across Lake St Clair
(Robert Haas, Bruce Manny, Don Schloesser)

IV. B. 6. b. Lacustrine aquatic beds

Lacustrine aquatic beds occur in lakes and are characterized by plants that form a continuous layer on or at the water's surface. Like palustrine aquatic beds, they can include algal mats, detached floating mats, and rooted plants, which are submerged, or have floating leaves. Again, at least 80 percent of their area is covered by some sort of vegetation. In marshes, aquatic beds are often referred to as the submergent zone, where they occur in association with emergent vegetation along the shoreline. Aquatic beds can also occur further out from the shore, where there is sufficient light to permit plant growth[224]. In areas protected from strong wave action, such as Anchor Bay, the bottom is almost entirely populated with plants, whereas they are scarce in the main part of the lake where the bottom is scoured by waves[225].

At least 21 submersed aquatic plant taxa occur in the St. Clair system[226]. Of these, seven taxa are common in Anchor Bay: wild celery, muskgrass, Eurasian watermilfoil, waterweed, as well as varieties of pondweed such as variable pondweed, redhead grass and narrow-leaf pondweed.

In Mitchell Bay, 15 taxa of submersed vegetation were found, but only four species contributed over 90% of the overall mean biomass, i.e., wild celery, muskgrass, horned pondweed and Eurasian water milfoil[227]. Six taxa are common in Lake St. Clair proper: wild celery, muskgrass, redhead grass, Eurasian watermilfoil, waterweed, and water stargrass[228].

Exotic species are also found in aquatic beds. Curly pondweed, an exotic submersed macrophyte taxa appears early in spring, is colonized by invertebrates that are eaten by waterfowl on their northern migration, and is also important as spawning substrate for fish[229]. Another exotic submersed macrophyte, Eurasian water milfoil can crowd out other underwater plants used by fish and waterfowl, but it provides an over wintering mat of decaying vegetation on which many aquatic invertebrates can feed[230].

In summer of 1994, unusually high quantities of submersed aquatic macrophytes floated into nearshore waters of the western and southern shores of Lake St. Clair, creating a nuisance[231]. Intensive sampling of 126 stations in the Lake St. Clair system in 1995 showed an increase in number of taxa, greater distribution, and greater abundance of aquatic macrophytes compared with earlier studies in 1978[232]. Macrophytes occurred at 92% of the stations, including the deeper waters, compared with 59% of the stations during 1978. Figure 2 shows the biodiversity of submerged macrophytes in 1995. Pondweed narrow-leaf forms, unknown narrow-leaf forms, Pondweed broad-leaf forms, water milfoil species, curly pondweed and an unknown submersed sedge entered Lake St. Clair proper between 1978 and 1995. During this time period, clarity of the water increased allowing greater light penetration, presumably because of removal

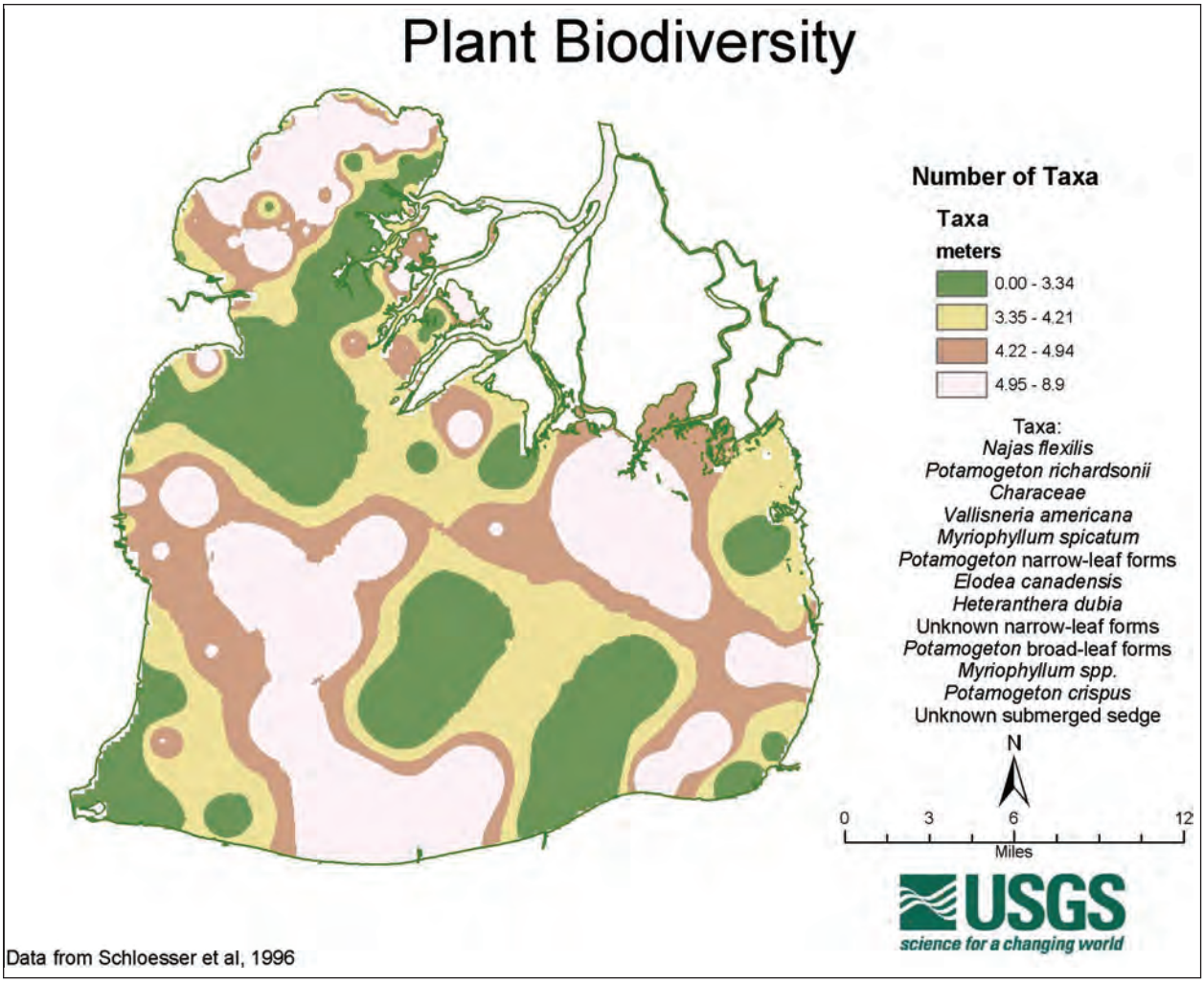


Figure IV B 6 b – 2
The number of plant taxa found in Lake St. Clair

of suspended materials by the invading zebra mussels. In addition discharges of sewage increased, which added plant nutrients such as phosphorus and nitrogen to the water[233].

The introduction and spread of the exotic zebra mussel throughout Lake St. Clair has decimated native unionid mussel populations. Historically North America supported the greatest diversity of freshwater mussels in the world. The rivers draining into Lake St. Clair, the St. Clair delta and the Detroit River were home to a diverse assemblage of freshwater mussels that are now rare, including rayed bean (State endangered - *http://web4.msue.msu.edu/mnfi/abstracts/aquatics/Villosa_fabalis.pdf*), purple lilliput (State endangered - *http://web4.msue.msu.edu/mnfi/abstracts/aquatics/Toxolasma_lividus.pdf*), purple wartyback (State species of special concern - *http://web4.msue.msu.edu/mnfi/abstracts/aquatics/Cyclonaias_tuberculata.pdf*), northern riffleshell (Federal and state endangered - *http://web4.msue.msu.edu/mnfi/abstracts/aquatics/Epioblasma_torulosa_rangiana.pdf*), snuffbox (State endangered - *http://web4.msue.msu.edu/mnfi/abstracts/aquatics/Epioblasma_triquetra.pdf*), wavy-rayed lamp (State threatened - *http://web4.msue.msu.edu/mnfi/abstracts/aquatics/Lampsilis_fasciola.pdf*), hickorynut (State species of special concern - *http://web4.msue.msu.edu/mnfi/abstracts/aquatics/Obovaria_olivaria.pdf*) and round hickory nut (State endangered - *http://web4.msue.msu.edu/mnfi/abstracts/aquatics/Obovaria_subrotunda.pdf*) (Personal communication, Doug Sweet, 2005). Urban development and pollution has destroyed mussel habitat in most of the area, however, and they have been devastated by the introduction of zebra mussels; native mussel diversity and abundance has been drastically reduced. Zebra mussels attach to a unionid's shell where they interfere with activities such as feeding, respiration, excretion, and locomotion, and effectively starve it to death. Although native mussels have been extirpated from most of Lake St. Clair, refuge sites exist,

primarily in shallow waters (< 1 m) of the St. Clair delta and the eastern shore of the lake. The St. Clair delta refuge site discovered in 1998-2001 (Figure 3) includes both wave-washed flats with firm sandy substrates and wetland areas with soft, muddy sediments[234]. More recent observations through 2004 indicate that these refuge areas are remaining stable for native mussels (Donald W. Schloesser, USGS, personal communication, 2004).

Burrowing mayflies are sensitive to environmental degradation and are absent or low in numbers from areas with poor sediment and water quality. Extensive sampling of the sediments of Lake St. Clair in 1985 produced an average of 279 burrowing mayfly nymphs per square meter, with the highest density being 3,099 nymphs per square meter (Schloesser et al. 1991). Subsequent sampling for burrowing mayfly nymphs at a single station in Lake St. Clair have shown a decline in nymphs to less than 100 nymphs per square meter in the spring of 2004 (Donald W. Schloesser, USGS, personal commun., 2004).

IV. B. 6. c. Riverine aquatic beds

Urban and industrial development has altered the fish community in riverine ecosystems. A survey of the Clinton River drainage by Smith et al. (1981)[235] failed to collect three fish species that require slow, weedy areas for spawning, i.e., the central mudminnow, grass pickerel and brook stickleback[236]. Of the 52 species of fish listed by the MDNR (see below) for the Clinton River, probably a number of these fish depend on the aquatic bed of the river for spawning and nursery areas.

Section IV Endnotes

1. Ashworth, William. 1991. The Encyclopedia of Environmental Studies. Facts on File, Inc. New York, NY.

2. Ibid.

3. Dobson, J.E., Bright, E.A., Ferguson, R.L., Field, D.W., Wood, L.L., Haddad, K.D., Iredale, H., Jenson, J.R., Klemas, V.V., Orth, R.J., Thomas, J.P., 1995. NOAA Technical Report NMFS 123: NOAA Coastal Change Analysis Program (C-CAP): Guidance for regional implementation. U.S. Department of Commerce, Seattle.

4. Chapman, K. A., 1986, updated 2003. Michigan's natural communities; draft list and descriptions. Michigan Natural Features Inventory, Lansing, MI.

5. Cowardin, L. , Carter, V., Golet, F., LaRoe, E., 1979. Classification of Wetlands and Deepwater Habitats of the United States. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C.

6. C-CAP, 2004. National Land Cover Classification Scheme. Accessed July 23, 2004: www.csc.noaa.gov/crs/lca/tech_cls.htmlop. cit.

7. National Oceanic and Atmospheric Administration (NOAA), 1995 - 2000. Coastal Change Analysis Data for the Lower Peninsula of Michigan and Lake St. Clair Shoreline of Southern Ontario. National Oceanic and Atmospheric Administration Coastal Services Center, Charleston, SC. 1995-2000.

8. Anderson, J. R., Hardy, E. E., Roach, J. T., and Witmer, R. E., 1976. A land use and land cover classification system for use with remote sensor data. U. S. Geological Survey Professional Paper, 964 p.

9. Dobson et al., 1995, *op. cit.*

10. NOAA, 1995 - 2000 *op. cit.*

11. NOAA, 1995 - 2000 *op. cit.*

12. NOAA, 1995 - 2000 *op. cit.*

13. Associated Press, 2001. Biologists transfer peregrine falcon chicks to safer site. Detroit News, 26 May, 2001.

14. Dobson, et al. 1995, *op. cit.*

15. NOAA, 1995 - 2000 *op. cit.*

16. Dobson, et al. 1995, *op. cit.*

17. Dobson, et al. 1995, *op. cit.*

18. Dobson, et al. 1995, *op. cit.*
19. OMAF, 2004. Field Crop Statistics. Ontario Ministry of Agriculture and Food. Accessed 10 May 2004: www.gov.on.ca/OMFRA/english/stats/crops

20. USDA, 1997a. 1997 Census of Agriculture - Highlights of Agriculture: 1997 and 1992, Macomb County, Michigan. United States Department of Agriculture. Accessed 29 January, 2004: www.nass.usda.gov/census/census97/highlights/mi/mic049.txt

21. USDA, 1997b. 1997 Census of Agriculture - Highlights of Agriculture: 1997 and 1992, St. Clair County, Michigan. United States Department of Agriculture. Accessed 29 January, 2004: www.nass.usda.gov/census/census97/highlights/mi/mic073.txt

22. Dunnigan 2003

23. NOAA, 1995 - 2000 op. cit.

24. Maynard, Laurie, and Douglas Wilcox, 1997. Coastal Wetlands. State of the Lakes Ecosystem Conference 1996; Background Paper.

25. NOAA, 1995 - 2000 op. cit.

26. SEMCOG, 2003. Land Use Change in Southeast Michigan: Causes and Consequences. Southeast Michigan Council of Governments. Detroit, Michigan.

27. Wild Farm Alliance, 2003a. Making connections for nature: the conservation value of farming with the wild. Wild Farm Alliance Briefing Paper. Accessed 3 May, 2004: http://wildfarmalliance.org/resources/wfaconnectbrief.pdf

28. Jackson, Dana L., and Jackson, Laura L., 2002. The farm as natural habitat. Island Press, Washington, DC.

29. Imhoff, Daniel, 2003. Farming with the wild: enhancing biodiversity on farms and ranches. Sierra Club Books, San Francisco.

30. Brewer, Richard, McPeek, Gail and Adams, Raymond, Jr., 1991. The Atlas of Breeding Birds of Michigan. Michigan State University Press, East Lansing.

31. Paskus, John, 2003. Summary of the Southeast Michigan Ecosystem Project: 1994-2001. Michigan Natural Features Inventory, Lansing.

32. Chesky, Edward D., and Wilson, William G., 2001. Eastern Lake St. Clair Important Bird Area Conservation Plan. Produced for the Eastern Lake St. Clair IBA Steering Committee and Stakeholders.

33. Canadian Nature Federation, 2004. Site Summary: Eastern Lake St. Clair, Southwestern Ontario, Ontario. Accessed 3 May, 2004: www.bsc-eoc.org/iba/site.jsp?siteID=ON012

34. Bakermans, Marcia H. and Rodewald, Amanda D., 2002. Enhancing Wildlife Habitat on Farmlands. Ohio State University Extension Factsheet W-14-2002., Columbus.

35. Yorke, Diane E., 1995. Wildlife Habitat Improvement: Farmlands and Wildlife. University of New Hampshire Cooperative Extension: Sept. 1995.

36. Brewer *et al.*, 1991, *op. cit.*

37. Paskus, 2003, *op. cit.*

38. Imhoff, 2003, *op. cit.*

39. Dobson, *et al.*, 1995, *op. cit.*

40. NOAA, 1995 - 2000 *op. cit.*

41. Comer, P.J., MacKinnon, W.A., Rabe, M.L., Cuthrell, D.L., Penskar, M.R., and Albert, D.A., 1995. A survey of lakeplain prairie. Michigan Natural Features Inventory, Lansing.

42. Bakowsky, Wasyl and J. L. Riley. 1992. A survey of the prairies and savannahs of southern Ontario. Thirteenth North American Prairie Conference; Spirit of the Land, Our Prairie Legacy. Windsor, Ontario, Corporation of the City of Windsor.

43. Swanson, David A., 1996. Nesting ecology and nesting habitat requirements of Ohio=s grassland-nesting birds: a literature review. Ohio Department of Natural Resources - Division of Wildlife, Ashley, Ohio.

44. Currier, C., 2001. Special animal abstract for *Ammodramus henslowii* (Henslow's sparrow). Michigan Natural Features Inventory. Lansing, MI. 4pp.

45. Knutson, M.G., Butcher, G., Fitzgerald, J., & Shieldcastle, J., 2001.Partners in Flight Bird Conservation Plan for the Upper Great Lakes Plain (Physiographic Region 16). USGS Upper Midwest Environmental Sciences Center in cooperation with Partners in Flight. LaCrosse, WI.

46. Dobson, *et al.*, 1995, *op. cit.*
47. Imhoff, 2003, *op. cit.*

48. Paskus, 2003, *op. cit.*

49. Jackson & Jackson, 2002, *op. cit.*

50. Paskus, 2003, *op. cit.*

51. Yorke, Diane E., 1995. Wildlife habitat improvements: farmlands and wildlife. University of New Hampshire Cooperative Extension.
52. Paskus, 2003, *op. cit.*

53. Brewer, R., McPeek, G.A., Adams, R. J., 1991. The atlas of breeding birds of Michigan. Michigan State University Press. Lansing.

54. Paskus, 2003, *op. cit.*

55. Kurta, Allen, 1995. Mammals of the Great Lakes region. University of Michigan Press. Ann Arbor.

56. Michigan Natural Features Inventory, 1999b. Michigan's special animals: endangered, threatened, special concern and probably extirpated. Endangered Species Program of the Michigan Department of Natural Resources, Lansing.

57. Chapman, 1986, *op. cit.*

58. Comer *et al.,* 1995*, op. cit.*

59. Faber-Langendoen, Don and P. F. Maycock. 1992. Vegetation Analysis of Tallgrass Prairie in Southern Ontario. Thirteenth North American Prairie Conference: Spirit of the Land, Our Prairie Legacy. Windsor, Ontario, Corporation of the City of Windsor.

60. Hayes, B. N. 1964. An ecological study of a wet prairie on Harsen's Island, Michigan. Michigan Botanist 3: 71-82.

61. Comer *et al.,* 1995*, op. cit.*

62. Curtis, J. T., 1971. The vegetation of Wisconsin: an ordination of plant communities. The University of Wisconsin Press, Madison.

63. Hull, John and Michael Williams. 1992. A Continuity of Tradition. Restoration and Management Notes 10:38-39.

64. Palmgren, Glenn, 2001. Stewardship management plan: Algonac State Park. Prepared for State Stewardship program, Parks and Recreation Bureau, Michigan Department of Natural Resources. Lansing.

65. Chapman, 1986, *op. cit.*

66. Comer *et al.,* 1995*, op. cit.*

67. Faber-Langendoen, Don and P. F. Maycock. 1992. Vegetation Analysis of Tallgrass Prairie in Southern Ontario. Thirteenth North American Prairie Conference: Spirit of the Land, Our Prairie Legacy. Windsor, Ontario, Corporation of the City of Windsor.

68 Fitzgerald, J.A., Herkert, J.R., and Brawn, J.D., 2000. Partners in Flight Bird Conservation Plan for The Prairie Peninsula (physiographic area 31). PIF Midwest Region. Brentwood, MO.

69. Brewer, R., McPeek, G.A., Adams, R. J., 1991. The atlas of breeding birds of Michigan. Michigan State University Press. Lansing.

70. Kurta, Allen, 1995, *op. cit.*

71. Michigan Natural Features Inventory, 1999a. Michigan's special plants. Endangered Species Program of the Michigan Department of Natural Resources. Lansing.

72. Paskus, John, 2004?. Michigan elements with habitat information within the project area. Michigan Natural Features Inventory. Lansing.

73. Cuthrell, D.L., Penskar, M.R., Higman, P.J., 2000. St. Clair Delta Lakeplain Prairie and Oak Savanna ecosystem project: Rare plant and insect surveys 2000. Prepared for: Michigan Department of Natural Resources, Natural Areas Program, Lansing.

74. Currier, C., 2001. Special animal abstract for *Ammodramus henslowii* (Henslow's sparrow). Michigan Natural Features Inventory. Lansing.

75. Currier, C., 2001. Special animal abstract for *Circus cyaneus* (Northern Harrier). Michigan Natural Features Inventory. Lansing.

76. Lee, Y., 2001. Special animal abstract for *Lanius ludovicianus migrans* (migrant loggerhead shrike). Michigan Natural Features Inventory Lansing.

77. Michigan Natural Features Inventory, 1999b. Michigan's special animals: endangered, threatened, special concern and probably extirpated. Endangered Species Program of the Michigan Department of Natural Resources, Lansing.

78. Jacobs, C., 2004. Walpole Island: Issues Paper. Draft prepared for the Great Lakes Commission.

79. Lesica, P. and F.W. Alendorf (1995) When are peripheral populations valuable for conservation. Conservation Biology 9: 753-760.

80. Metcalf-Smith, Environment Canada. Personal communication. (2004).

81. Chapman, L.J. and D.F. Putnam (1984) The Physiography of Southern Ontario Ontario geologicasl Survey Special Volume 2 Ontario Ministry of Natural Resources. 270 pp + maps.

82. Woodliffe, A. and G.M. Allen (1998) A Lifescience Inventory and Ranking of 30 Natural Areas of Walpole island Indian Reserve. Unpublished Report. 150 pp + maps + appendices.

83. Ecologistic Limited. (1979) Biophysical Walpole Island Indian Reserve. Prepared for Walpole Island Indian Band Council. Under contract from Indian and Northern Affairs.

84. Faber-Langendoen, D. and P.F. Maycock (1987) Composition and soil-environment of prairies on Walpole Island, Southwestern Ontario. Canadian Journal of Botany 65: 2410-2419.

85. Draper, W.B., M.E. Gartshore and J.M. Bowles (2002) Land Life Science Inventory and Evaluation of St. Williams crown Forest. Ontario Ministry of Natural Resources. Xiv + 1,119 pages + 15 folded maps in 2 Volumes.

86. Crow, C., J. Demelo, J. Hayes, J. Wells and T. Hundey (2003) Walpole Island Land Use change 1972-1998. Unpublished class report, Department of Geography, University of Western Ontario.

87. Bakowsky, W. (1996) Natural Heritage Resources of Ontario: Vegetation Communities of Southern Ontario. Natural heritage Information Centre, Ontario Ministry of Natural Resources, Peterborough, Ontario. 21 pp

88. The Nature Conservancy (1995) Significant Areas of Biological Diversity in the Great Lakes Basin, Ontario. The Natura Conservancy Midwestern Regional Office, Minneapolis, Minnesota and Great Lakes Programs Office, Chicago, Illinois

89. Snell, E.A. (1987) Wetland distributuin and conservation in southern Ontario. Inldand Waters and Land Directorate, Environment Canada, Burlington, Ontario.

90. Chapman, 1986, *op. cit.*

91. Paskus, 2003, *op. cit.*

92. Curtis, 1971, *op. cit.*

93. Hull & Williams, 1992, *op. cit.*

94. Abrams, M.A., 1998. The red maple paradox; what explains the widespread expansion of red maple in eastern forests? Bioscience; 48(5):355-364.

95. Abrams, 1992. Fire and the development of oak forests. Bioscience; 42(5):346-353.

96. Abrams, 2003. Where has all the white oak gone? Bioscience; 53(10):927-939.

97. Curtis, 1971, *op. cit.*

98. Paskus, 2003, *op. cit.*

99. Paskus, 2003, *op. cit.*

100. Curtis, 1971, *op. cit.*

101. Curtis, 1971, *op. cit.*

102. Brewer, R., McPeek, G.A., Adams, R. J., 1991, *op. cit.*

103. Paskus, 2003, *op. cit.*

104. Paskus, John, 2004, *op. cit.*

105. Cohen, J. G., 2004. Natural Community abstract for mesic southern forest. Michigan Natural Features Inventory, Lansing, MI.

106. Chapman, 1986, *op. cit.*

107. Paskus, 2003, *op. cit.*

108. Curtis, 1971, *op. cit.*

109. Barnes, Burton V., Zak, Donald R., Denton, Shirley R., and Spurr, Stephen H., 1998. Forest Ecology. John Wiley and Sons, Inc., New York.

110. Paskus, 2003, *op. cit.*

111. Waldron, 2003. Trees of the Carolinian Forest: a guide to species, their ecology and uses. The Boston Mills Press, Erin.

112. Curtis, 1971, *op. cit.*

113. Kurta, Allen, 1995, *op. cit.*

114. Brewer, R., McPeek, G.A., Adams, R. J., 1991. The atlas of breeding birds of Michigan. Michigan State University Press. Lansing.

115. Paskus, 2004, *op. cit.*

116. Bakowsky & Riley, 1992, *op. cit.*

117. Cohen, J.G., 2001. Natural community abstract for oak barrens (lakeplain oak opening). Michigan Natural Features Inventory, Lansing, MI. 9pp.

118. Bakowsky, Wasyl D., 1999. Rare Vegetation of Ontario: Tallgrass Prairie and Savannah. NHIC Newsletter, Spring, pp. 3-6.

119. Chapman, 1986, *op. cit.*

120. Curtis, 1971, *op. cit.*

121. Nuzzo, V. A., 1986. Extent and status of midwest oaksavanna: presettlement and 1985. Natural Areas Journal. 6(2):6- 36.

122. Abrams, 1992, *op. cit.*

123. Curtis, 1971, *op. cit.*

124. Nuzzo, 1986, *op. cit.*

125. Cohen, 2001, *op. cit.*

126. Bakowsky, 1999, *op. cit.*

127. Cohen, 2001, *op. cit.*

128. Palmgren, G., 2001. Draft Review: Stewardship management plan Algonac State Park. Prepared for State Stewardship Program, Michigan Department of Natural Resources, Lansing.

129. Bakowsky, 1999, *op. cit.*

130. Cohen, 2001, *op. cit.*

131. Palmgren, 2001, *op. cit.*

132. Cohen, 2001, *op. cit.*

133. Cuthrell, D.L., Penskar, M.R., Higman, P.J., 2000. St. Clair Delta Lakeplain Prairie and Oak Savanna ecosystem project: Rare plant and insect surveys 2000. Prepared for: Michigan Department of Natural Resources, Natural Areas Program, Lansing.

134. Cohen, 2001, *op. cit.*

135. Paskus, 2004, *op. cit.*

136. C-CAP, 2004, *op. cit.*

137. NOAA, 1995 - 2000 *op. cit.*

138. Paskus, 2003, *op. cit.*

139. Paskus, 2003,*op. cit.*

140. C-CAP, 2004, *op. cit.*

141. Cowardin, L.M., Carter, Virginia, Golet, F.C., and LaRoe, E.T., 1979. Classification of wetlands and deepwater habitats of the United States: U.S. Fish and Wildlife Service Report FWS/OBS-79/31, 131 p.

142. Mitsch, William J. & James G. Gosselink, 2000. Wetlands, Third Edition. John G. Wiley and Sons, New York.

143. C-CAP, 2004, *op. cit.*

144. Cowardin et al, 1979, *op. cit.*

145. Minc, Leah D., 1997. Great Lakes Coastal Wetlands: An Overview of Controlling Abiotic Factors, Regional Distribution, and Species Composition. A Report in 3 Parts submitted to Michigan Natural Features Inventory.

146. McCullough, Gary B., 1981. Wetland Losses in Lake St. Clair and Lake Ontario, in: Proceedings of the Ontario Wetlands Conference, September 18/19, 1981. Federation of Ontario Naturalists, Don Mills.

147. C-CAP, 2004, *op. cit.*

148. Chesky and Wilson, 2001, *op. cit.*

149. Chapman, 1986, *op. cit.*

150. C-CAP, 2004, *op. cit.*

151. NOAA, 1995 - 2000 *op. cit.*

152. Chapman, 1986, *op. cit.*

153. Paskus, 2003, *op. cit.*

154. Chapman, 1986, *op. cit.*

155. Mitsch & Gosselink, 2000, *op. cit.*

156. Paskus, 2003, *op. cit.*

157. Paskus, 2003, *op. cit.*

158. Eggers & Reed, *op. cit.*

159. Mitsch & Gosselink, 2000, *op. cit.*

160. Eggers, Steve D., & Donald M. Reed, 1987. Wetland Plants and Plant Communities of Minnesota and Wisconsin. U. S. Army Corps of Engineers, S. Paul District, St. Paul.

161. Paskus 2004, *op. cit.*

162. Chapman, 1986, *op. cit.*

163. Comer *et al.*, 1995, *op. cit.*

164. Albert, D.A. and Kost, M.A. 1998a. Natural community abstract for lakeplain wet-mesic prairie. Michigan Natural Features Inventory. Lansing, MI. 4pp.

165. Albert, D.A. and Kost, M.A. 1998b. Natural community abstract for lakeplain wet prairie. Michigan Natural Features Inventory. Lansing, MI. 4pp.

166. Comer, P.J., MacKinnon, W.A., Rabe, M.L., Cuthrell, D.L., Penskar, M.R., and Albert, D.A., 1995. A survey of lakeplain prairie. Michigan Natural Features Inventory, Lansing.

167. Paskus, 2004, *op. cit.*

168. Albert, D. A. 2001. Natural community abstract for Great Lakes Marsh. Lansing, Michigan Natural Features Inventory: 11pp.

169. Paskus, 2003, *op. cit.*

170. Albert, 2001, *op. cit.*

171. Minc, 1997, *op. cit.*

172. Maynard & Wilcox, 1997, *op. cit.*

173. Herdendorf C. E., Raphael, C. N., Jaworski, E., and Duffy, W. G., 1986. The ecology of Lake St. Clair wetlands: a community profile. Prepared for National Wetlands Research Center, Fish and Wildlife Service, U. S. Department of the Interior, Washington, DC.

174. USACE, 2004. Lake St. Clair Hydrograph, 1918- present. United States Army Corps of Engineers, Detroit District. Accessed 12 May 2004:

    http://155.79.127.51/index.cfm?chn_id=1383&year_id=0&lake_id=3

175. Albert, 2001, *op. cit.*

176. Herdendorf et al., 1986, *op. cit.*

177. Chapman, 1986, *op. cit.*

178. Herdendorf *et al.*, 1986, *op. cit.*

179. Minc, 1997, *op. cit.*

180. Chesky & Wilson, 2001, *op. cit.*

181. Maynard, Laurie, and Douglas Wilcox, 1997. Coastal Wetlands. State of the Lakes Ecosystem Conference 1996; Background Paper.

182. McPeek, M. A., & Adams, R. J., 1994. The Birds of Michigan. Indiana University Press, Bloomington.

183. Herdendorf *et al.*, 1986, *op. cit.*

184. Maynard & Wilcox, 1997, *op. cit.*

185. Jacobs, Clint, Johnson, Aimee, & Waboose, Janis, 2002. Species at risk on the Walpole Island First Nation. Walpole Island Heritage Center, Walpole Island First Nation.

186. Herdendorf *et al.*, 1986, *op. cit.*

187. Metsger et al., 2003, *op. cit.*

188. Chapman, 1986, *op. cit.*

189. Paskus, 2003, *op. cit.*

190. NOAA, 1995 - 2000 *op. cit.*

191. Barnes, B. V., and Wagner, W. H., 2004. Michigan Trees. The University of Michigan Press, Ann Arbor.

192. Curtis, 1959, *op. cit.*

193. Paskus, 2003, *op. cit.*

194. Barnes, 2004, *op. cit.*

195. Curtis, 1959, *op. cit.*

196. Michigan Natural Features Inventory, 1999a, *op. cit.*

197. Michigan Natural Features Inventory, 1999b, *op. cit.*

198. Chapman, 1986, *op. cit.*

199. Barnes, *et al.* 1998, *op. cit.*

200. Barnes, *et al.* 1998, *op. cit.*

201. Barnes, 2004, *op. cit.*

202. Barnes, 2004, *op. cit.*

203. Curtis, 1971, *op. cit.*

204. Paskus, 2003, *op. cit.*

205. Inman, Rainy L., Prince, Harold H., Hayes, Daniel B., 2002. Avian communities in forested riparian wetlands of southern Michigan, USA. Wetlands 22(4) 647-660.

206. Chapman, 1986, *op. cit.*

207. NOAA, 1995 - 200, *op. cit.*

208. Zorn TG, Seelbach PW (1992) A historical perspective of the Clinton River watershed and its fish communities. Michigan Department of Natural Resources, Fisheries Division, Lansing, MI, Fisheries Technical Report No. 92-10.

209. Chapman, 1986, *op. cit.*

210. Herdendorf et al., 1986, *op. cit.*

211. Paskus, 2003, *op. cit.*

212. Leach JH (1991) Biota of Lake St. Clair: Habitat evaluation and environmental assessment. Hydrobiologia 219:187-202

213. Edsall TA, Gannon JE (1991) A Profile of Lake St. Clair. MICHU-SG-91-701. Michigan Sea Grant College Program, Ann Arbor, MI.

214. Holtschlag, D.J., and Koschik, J.A., 2004, Hydrodynamic simulation and particle-tracking techniques for identification of source areas to public water intakes on the St. Clair-Detroit River Waterway in the Great Lakes Basin, U.S. Geological Survey Scientific Investigations Report 2004-5072 (in press).

215. Leach, 1991 *op. cit.*

216. Zorn TG, Seelbach PW (1992) A historical perspective of the Clinton River watershed and its fish communities. Michigan Department of Natural Resources, Fisheries Division, Lansing, MI, Fisheries Technical Report No. 92-10.

217. Goodyear CD, Edsall TA, Dempsey DMO, Moss GD, Polanski PE (1982) Atlas of the Spawning and Nursery Areas of Great Lakes Fishes. Performed for Office of Biological Services, US Fish and Wildlife Service, Washington, DC. FWS/OBS-82-52. 10 Vol.

218. Strayer D (1980) The freshwater mussels (Bivalvia: Unionidae) of the Clinton River, Michigan, with comments on man's impact on the fauna, 1870-1978. Nautilus, 94(4), 142-149.

219. Staton SK, Dextrase A, Metcalfe-Smith JL, Di Maio J, Nelson M, Parish J, Kilgour B, Holm E (2003) Status and trends of Ontario's Sydenham River ecosystem in relation to aquatic species at risk. Environ. Monit. Assess. 88:283-310.

220. Ibid.

221. Metcalfe-Smith JL, di Maio J, Staton SK, DeSolla SR (2003) Status of freshwater mussel communities of the Sydenham River, Ontario, Canada. Amer. Midland Nat. 150:37-50.

222. NOAA Coastal Services Center, 2003, *op. cit.*

223. NOAA Coastal Services Center, 2003, *op. cit.*

224. NOAA Coastal Services Center, 2003, *op. cit.*

225. Leach, 1991 *op. cit.*

226. Edsall TA, Manny BA, Raphael CN (1988) The St. Clair River and Lake St. Clair, Michigan: An Ecological Profile. Biological Report 85(7.3), U.S. Fish and Wildlife Service, Ann Arbor, MI. 130 pp.

227. Leach, 1991 *op.cit.*

228. Edsall TA, Gannon JE (1991) A Profile of Lake St. Clair. MICHU-SG-91-701. Michigan Sea Grant College Program, Ann Arbor, MI.

229. Edsall *et. al.*, 1991, *op.cit.*

230. Schloesser DW (1986) A field guide to valuable underwater aquatic plants of the Great Lakes. U. S. Fish and Wildlife Service, Great Lakes Fishery Laboratory, Ann Arbor, MI, and Michigan State University, Cooperative Extension Service, East Lansing, MI, Coop. Ext. Serv. Bull. E-1902, 32 pp.

231. Schloesser DW, Manny BA, Edsall TA (1996) Distribution and relative abundance of submersed aquatic plants in the Lake St. Clair ecosystem August-September, 1995. Pages 1-29 in Edsall TA (ed.) Aquatic plant management investigations of Lake St. Clair, Michigan, 1995. Contract Completion Report for Detroit District Army Corps of Engineers, National Biological Service, Great Lakes Science Center, Ann Arbor, MI. 67 pp.

232. Ibid.

233. Ibid.

234. Zanatta, DT; Mackie, GL; Metcalfe-Smith, JL; Woolnough, DA A (2002) Refuge for native freshwater mussels (Bivalvia: Unionidae) from impacts of the exotic zebra mussel (Dreissena polymorpha) in Lake St. Clair. J. Great Lakes Res.28(3):479-489.

235. Smith GR, Stoehr SJ, Schultz D (1981) Survey of fishes of the Clinton River drainage, Michigan, September 23, 1981. Museum of Zoology, The University of Michigan, Ann Arbor. [Cited in Zorn and Seelbach 1992]

236. Zorn TG and Seelbach PW, 1992, *op.cit.*

Section V. System Stressors and Specific Responses

V. A. Land Development and Urban Expansion

Land development and urban growth can be viewed as the ultimate stressor–the source of the collective impacts of all human activity across the landscape, including the impacts listed under separate subsections within this section. Although all development impacts habitat, not all development impacts habitat equally. Development can be viewed as any conversion or change in the land cover due to a human activity, such as agriculture (since it involves a range of landscape modifications) as well as urban development, which includes cities, towns and villages. Urban development includes the buildings (houses, stores, office buildings, factories, etc.), the roads and highways necessary to connect those buildings, the other infrastructure and facilities needed to service these areas, including water and sewer networks, treatment plants, and a variety of other networks and facilities–from rail lines and yards to ports and marinas.

V. A. 1. Urban Expansion

One of the most significant land use issues in the Great Lakes region is the continuing growth of major metropolitan areas and sprawl of residential areas and related development[1]. C-CAP data show that 23 percent of the project area, or approximately 175,000 acres (70,819 hectares) is "developed" land, including both high and low intensity developed lands. Most development occurs in the Michigan portion of the project area, in Detroit and its northern suburbs[2]. Only about 9 percent of the Canadian side of the project area is considered developed while about 43 percent of the land on the U.S. side is developed (See Figure #___ in Section IV. A. 1.).

HIGHLIGHT

Since World War II, the human footprint on the land around the Great Lakes has been transformed by a major shift in land development patterns from high-density urban development to low-density suburban and rural development.

Urban development and expansion on the U.S. side of Lake St. Clair increased sharply in the early 1900s. Since World War II, the human footprint on the land around the Great Lakes has been transformed by a major shift in land development patterns from high-density urban development to low-density suburban and rural development[3]. Over the past half century, distinct cities, towns and rural areas evolved into a sprawling metropolis. Dominated by strip malls and subdivisions, the older suburbs are connected by a vast network of wide lane roads and boulevards. In newer developments, rural roads are congested with traffic loads that they were never intended to accommodate. The causes and consequences of sprawling development are the subject of much debate, some of which has been discussed in Section II. B. of this document.

Urban expansion is predominant on the U.S. side of Lake St. Clair while the Canadian side remains primarily agriculture with pockets of urban development. Analysis of the C-CAP land cover data for 1995 and 2000 shows a net increase of 4,800 acres (1,942.5 hectares) in total high and low intensity development within the project area and a commensurate reduction in all non-developed land categories[4]. (See Section IV. A.). On Walpole Island First Nation, although development tends to be lower density, the pressure to develop housing and infrastructure is growing as the population increases. Pristine natural areas are often used for home sites, in spite of a pervading respect for nature among community members, as land for building is difficult to acquire.

Urban development and expansion destroys and degrades habitat in numerous ways. Construction activities remove all or nearly all vegetation on the construction site and the soil is compacted and graded, decimating the natural habitat once provided by the site. Without vegetation to intercept the flow of rainfall, construction sites generate large volumes

FACT

Without vegetation to intercept the flow of rainfall, construction sites generate large volumes of sediment that readily runs off into nearby storm drains, streams, rivers and lakes.

of sediment that readily runs off into nearby storm drains, streams, rivers and lakes. Section V. A. 5. discusses the impacts of soil erosion and sedimentation.

Urban development results in impervious land cover in the form of roads, parking lots, sidewalks and rooftops. Impervious cover threatens water quality by preventing precipitation from slowly infiltrating into the ground. Specific issues associated with improper stormwater handling will be addressed in the following subsection. Although all development results in some impervious cover, the impacts of development are exacerbated by sprawling (e.g., low-density) development that requires more roads, rooftops and parking lots to connect the shops, homes and workplaces and house the automobiles necessary to get there. The "green" areas around these developments rarely compensate for the impervious cover as the soil is compacted and vegetation is usually comprised of lawns and ornamental shrubs and trees with lower water absorption and filtering capacity than native grasses, trees and shrubs.

There is growing interest in policies and programs, often known collectively as "smart growth" that aim to redirect public investments into existing developed areas, protect existing open spaces and guide urban development in a more sustainable and less environmentally-damaging, manner. In Michigan, efforts are underway to implement a series of recommendations made by the Governor's Land Use Leadership Council in 2003. Smart growth initiatives in Ontario have primarily been focused in what is known as the "golden horseshoe" area, generally those counties that border Lake Ontario, but interest in smart growth appears to be growing.

CASE STUDY

Macomb Town Center

The Macomb Township offices have been master planned into a large scale new urbanist development in the north central portion of Macomb Township which integrates commercial and residential development in a compact urban form. The new municipal offices, civic center, community recreation center, and senior center are all focal points in this two square mile area of new urbanism. The civic portion of development is well under way and residential development is now proceeding. This is one of the largest new urbanist developments within the Midwest (personal communication, Gerald Santoro).

However, urban sprawl has become entrenched in North American culture and significant changes in land development patterns will take concerted long term efforts that cut across all public policy arenas. Changes in tax policy, transportation policy, real estate policy and others will be required before a more planned or sustainable urban form or development pattern becomes well established.

V. A. 2. Stormwater

Historically, rain was viewed as something positive; farmers relied on rain for the success of their crops and rainwater recharged aquifers and the water table. Much of the water soaked gradually into the ground and was filtered through soil and plants. In the process, it was cleansed and cooled. Infiltrated stormwater moderated the flow of rivers and streams because it was released gradually throughout the year. As impervious surfaces have increased dramatically with increasing urbanization, however, stormwater has become one of the major sources of pollution degrading our water resources[5,6].

HIGHLIGHT

Urban sprawl has become entrenched in North American culture and significant changes in land development patterns will take concerted long term efforts that cut across all public policy arenas.

Traditional stormwater management practices have focused on directing stormwater into ditches and drains as rapidly as possible. Once water enters the drain system, it is routed directly into rivers and streams, and

CASE STUDY
Anchor Bay Watershed Management Plan

The Anchor Bay Watershed Management Plan was developed by a committee comprised of representatives from both county and community agencies, to fulfill their respective requirements under the Michigan Department of Environmental Quality Phase II Watershed-based Storm Water Permit. The Plan identified stakeholders, gathered available water quality, stormwater flow and habitat information, identified known impairments, identified and prioritized pollutant sources and established goals for the watershed. It then identified actions for which the communities would take responsibility, highlighted gaps between goals and planned activities and developed a list of recommended activities to be implemented by the local governmental agencies. With the completion of the plan, the individual communities qualify for Clean Michigan Initiative (CMI) grant funding to implement the activities recommended in the plan.

Additionally, the EPA has just awarded a $95,000 grant to study sources of identified pollutants and the hydrology of the waterways. Studying the hydrology, or flows, of the waterways will help the municipalities and the county identify whether the storm water retention requirements currently in place will prevent flooding and erosion as more land is developed. Below is the link to the Anchor Bay Watershed Project webpage.
http://awp.stclaircounty.org

can cause considerable damage downstream both to riparian lands and overall water quality[7]. Impervious surfaces add not only to the amount and rate of storm water entering our surface waters, but they also carry a number of pollutants such as fertilizers, pesticides, oil and bacteria from animal waste. The net result is increases in the frequency and duration of flood events, reduction in aquatic biodiversity, increased stream bank erosion and decreased infiltration into the groundwater table[8].

Governments on both sides of the border treat stormwater as a serious pollutant and implement stormwater control programs. Michigan has been delegated authority from the federal government to implement the Phase II stormwater program under the National Pollutant Discharge System (NPDES) permit program. Under this program, communities are required to develop Stormwater Management Plans to reduce pollutants being discharged through stormwater. Individual communities may obtain jurisdiction–based stormwater general permits or they can cooperate with other municipalities to obtain a watershed-based storm water general permit. Although the requirements are similar for both permits, the watershed-based permit provides far more flexibility in how these requirements are met and offers the opportunity for cost-sharing for some stormwater controls, as well as improved water quality throughout the entire watershed[9].

In Ontario, the Province of Ontario has required municipalities to address stormwater as part of the planning and development process. A combination of stormwater management practices are usually required to meet the multiple objectives of stormwater management. In 2003, an updated Storm Water Management Planning and Design Manual was released by the Ontario Ministry of the Environment. The manual serves as a baseline reference document for review of stormwater management applications for approval under Section 53 of the Ontario Water Resources Act, and is available online at: *www.ene.gov.on.ca/envision/gp/4329eindex.htm.*

FACT

Current best management practices for stormwater handling focus on watershed based planning, with the goal of reproducing pre-development hydrological conditions.

Current best management practices for stormwater handling focus on watershed based planning, with the goal of reproducing pre-development hydrological conditions[10]. They generally include an emphasis on protecting critical areas such as floodplains, wetlands, recharge areas, shorelines, stream courses and open spaces during the development process. In the remaining areas which can be developed, features such as vegetated swales, water gardens, green roofs, buffer strips, permeable paving and the use of native plants can slow the movement of water across the landscape and increase infiltration on site[11,12]. The Center for Watershed Protection has a number of useful publications, many of which can be downloaded from their website at: *www.cwp.org.*

V. A. 3. Habitat Fragmentation and Destruction

While there are a number of negative effects on natural systems associated with land development and urban expansion, the most direct impact is simply the outright destruction of complex functioning natural communities and the replacement of these communities with simplified, ecologically depauperate landscapes. Healthy ecosystems provide a multitude of services for both humans and wildlife; erosion control, sediment retention, soil formation, nutrient cycling, waste treatment, pollination, water supply and water regulation are just a few examples[13]. Short of outright habitat destruction, however, fragmentation of the remaining habitat results in myriad negative effects on ecosystem function, habitat quality, species diversity and species abundance. As discussed in Sections II. B. and II. D., demographic shifts and the expansion of urban/suburban development across the landscape have resulted in less wildlife habitat and a higher degree of fragmentation of the habitat that remains.

FACT
Healthy ecosystems provide a multitude of services for both humans and wildlife; erosion control, sediment retention, soil formation, nutrient cycling, waste treatment, pollination, water supply and water regulation are just a few examples.

The impacts of fragmentation vary widely, depending on the natural community under consideration, and the particular barriers separating fragments. Roads, for example can be crossed easily by most birds, but for earthbound animals like turtles, they are a source of dramatically increased mortality rates. An agricultural field presents a foraging opportunity for species such as white-tailed deer, but may completely prevent dispersal for some salamanders or woodland soil organisms. The size and shape of fragments, the distance and type of barriers by which they are separated, and the existence of connections or corridors between them can all contribute to the impact of habitat fragmentation on species richness and abundance, and ecosystem stability[14, 15].

Fragmentation can affect species richness and abundance in a number of ways. In general, animals requiring interior habitat are the first to decline[16]. Forest breeding birds, for example require large areas of forest interior. In smaller parcels, as the ratio of forest edge increases relative to the interior, nest predation by cowbirds can eliminate successful breeding efforts. Parcel shape can also be critical in determining available interior; circular parcels have low amounts of edge relative to their interior area, while long narrow parcels or those with irregular edges can consist almost entirely of edge. Edge-related increases in nest predation may extend as far as 200 meters into temperate forests, and accordingly, many interior bird species need at least several hundred hectares of forest for successful reproduction[17].

HIGHLIGHT
Demographic shifts and the expansion of urban/suburban development across the landscape have resulted in less wildlife habitat and a higher degree of fragmentation of the habitat that remains.

Animals with large territories are also first to disappear from an area as habitat becomes fragmented. Animals with smaller territories, in contrast, tend to persist longer, and in some cases, may become more abundant in small areas, as crowding increases.

Animals that specialize in edge habitats can increase significantly with fragmentation, but this is not always a good thing. White-tailed deer, for example, specialize in woodland edge, and their numbers are far higher than they were prior to European settlement. Because they wander widely, they can affect forest quality significantly and in some areas, they are a significant threat to plant communities because of over browsing[18]. In general weedier plant species tend to proliferate along habitat edges, and invasive species such as garlic mustard can become a serious problem.

As habitat fragments become increasingly isolated, movement between individual parcels is limited. As populations of plants and animals become increasingly isolated, gene flow between them is reduced, and with it, genetic diversity[19]. At the point when the dispersal of individuals between habitat fragments is eliminated, the possibility of local populations becoming extinct becomes increasingly likely. Conversely, when fragments are close, or connected by corridors, vacant habitats can be recolonized by dispersing individuals from adjacent habitats[20].

HIGHLIGHT

Careful planning is needed to provide a network of suitable habitat patches and effective corridors to maintain connectivity between them.

Habitat fragmentation can result in particular problems for plants. In a number of rare plants, as habitat fragments become smaller, seed output and seedling viability are reduced. Because plants don't move around, gene flow can be limited; for plants that depend on specialized pollinators or seed dispersers, as the size of habitat patches decreases, so do the opportunities for successful reproduction. Often, a population of plants may survive for many years; plant reproduction, however, is affected far more rapidly, and the decline in numbers of a particular species is often not noticed until it is too late[21, 22].

Careful planning is needed to provide a network of suitable habitat patches and effective corridors to maintain connectivity between them. Planning for conservation areas is discussed later in greater detail in Section 8.

V. A. 4. Fire Suppression

Although it may seem counterintuitive, fire is a critical process in many natural communities. Its benefits are discussed as a natural stressor in Section V. F. 2., but its suppression also needs to be examined as a significant cause of habitat loss and transformation. A number of the natural communities considered most at risk within the project area are considered fire-dependent systems: lakeplain oak opening, lakeplain mesic sand prairie and lakeplain wet-mesic prairie[23, 24, 25]. Historically, lightening strikes caused some fires and when population densities were lower, they were allowed to burn unhindered. Native Americans also used fire as a management tool: to clear land for planting, to encourage the new growth of vegetation for game and to maintain open conditions in the forests to facilitate passage through them[26].

CASE STUDY

Cultural traditions, traditional knowledge and habitat

The loss of cultural traditions and traditional knowledge constitutes a significant stressor for natural habitat on Walpole Island First Nation. The Walpole Island community is justifiably proud of its rich natural heritage, but community surveys have indicated that many community members are unaware of just how important this natural heritage is to other Canadians. In recent surveys, respondents listed forest, wetland and shoreline as important components of their natural heritage, but not a single person listed prairie by name. The Walpole Island prairies and species that they contain – so rich and rare throughout Canada – are collectively known as "weeds" by the Walpole Island community, although this term does not carry the same connotation that it might among non-native people. At the same time, the traditional value that the land once held for community members is subtly changing.

There are few fluent speakers of the Native languages on Walpole Island and most of them are elders. The collective (cont.)

In grasslands, periodic fire prevents gradual succession to brush or forest. It clears away dead vegetation from previous years, releasing nutrients, permitting light to reach smaller, more conservative plants and warming the soil surface. In some cases, some species of plants may actually require fire to germinate; the seed of New Jersey tea, for example, requires heat before it will germinate[27]. As fires were suppressed, many historical prairies and savannas in the U.S. and Canada have been replaced by forest, leaving only a few open grown oaks, or lingering prairie indicator species as evidence of their former existence. In forest ecosystems, in the absence of fire, many oak woodlands are being invaded by red maple or beech and sugar maple[28].

Although early settlers initially followed Native practices in burning to prepare fields for planting, as more and more buildings were constructed this was no longer practical. As towns and cities developed, natural

ecological and cultural knowledge about the ecosystems of Walpole Island has by tradition been passed down orally and is not shared with outsiders. Much of this knowledge is being lost. Documentation of some of these values and traditions would safeguard against loss, but at the same time, would represent a weakening of the oral traditions.

While many traditions are maintained and handed down by elders to succeeding generations, others have lost their original context. Traditional methods of hunting and harvest, in many cases, have been supplanted by a reliance on modern conveniences that include chain saws, motor boats, ATVs and rifles. Individual rights to hunt, fish and harvest are an important part of First Nations identity and are often a source of income to the people who practice them, but without the feedback mechanisms and respect for the land that are part of the tradition of community involvement, over exploitation of the resources is possible.

Harvesting species such as sweetgrass is a traditional activity of cultural importance. It used to be done within a context of holistic habitat management, but now is often seen as a purely economic activity. Current harvest levels are probably not sustainable and damage to other species may occur during harvesting also.

Walpole Island Heritage Centre has been active in taking the lead in activities that will address some of the stressors and knowledge gaps that have been identified. Community input is of prime importance because initiatives are unlikely to be successful without endorsement from the population. An engaged population, however, will provide much of the habitat protection required. Traditional respect for the natural world and Native philosophies of appropriate interactions with nature are fundamental to the identity of First Nations peoples and are considered sacred obligations. Conservation of natural habitats cannot be separated from cultural issues[33].

fires could no longer burn freely, but were instead suppressed. On Walpole Island First Nation, fire has long been a part of traditional land management[29], and its prairies, savannas and oak forest reflect this. Tiny species such as pink milkwort, small white lady's slipper orchid and yellow stargrass, which are rare, protected or extirpated elsewhere are abundant[30].

The same concerns which have restricted the use of fire elsewhere, however, are beginning to take their toll on Walpole Island as well. The overall frequency and extent of burning has decreased as danger to people and property has increased with the intensity of development. Complaints about air pollution from neighboring communities in Canada during burns are frequent. In addition, many of the cultural aspects of the use of fire are no longer being transmitted effectively. Many fires are not planned as management activity and very few formally prescribed fires have been conducted. Many fires that do occur are the result of arson, diminishing community support for a dwindling practice[31].

Estimates based on the examination of aerial photos suggest that Walpole Island's prairies have been reduced from 1,804 acres (730 hectares) in 1972 to about 1,161 acres (470 hectares) in 1998, a loss of 36 percent. Some of this is the result of conversion to agriculture and housing, but most is due to encroachment by forest and open woodland in the absence of fire. Similarly, oak savanna has been reduced from 1409 acres (570 hectares) in 1972 to 890 acres (360 hectares) in 1998, a loss of 37 percent, mainly attributable to closing in of the forest canopy[32]. Walpole Island's grassland communities provide the best remaining example of what much of the region once looked like, but they are as vulnerable to the effects of fire suppression as the extensive prairies and savannas that once existed throughout the lakeplain.

V. A. 5. Agriculture

Agricultural lands typically include cultivated lands (orchards, nurseries, crops) as well as animal farming operations. This distinction is important when evaluating land use impacts, particularly in light of evolving agricultural practices. As noted in Section IV. A. 3., cultivated lands make up the single largest category of land cover within the project area, occupying nearly 50 percent of the total area[34]. Cultivated lands impact habitat by altering the natural vegetative cover. Habitats are destroyed as forests, wetlands and other natural vegetation are cleared, drained and/or diked for agriculture. In most areas within the project area, new lands are no longer being cleared for agriculture, with the exception of Walpole Island First Nation where economic pressures often encourage the conversion of natural areas to agriculture, which provides a steady income stream through agricultural leases[35]. For the plants and animals living on the land, both on Walpole Island and elsewhere, their habitat is simply and completely lost when the land is converted to agricultural uses.

Agricultural lands are an important source of soil erosion and sedimentation, chemical runoff (herbicides, pesticides, and insecticides) and nutrient runoff (nitrogen and phosphorous). (See Section V. B. 3. for a more detailed description

HIGHLIGHT

Agricultural lands are an important source of soil erosion and sedimentation, chemical runoff (herbicides, pesticides, and insecticides) and nutrient runoff (nitrogen and phosphorous).

of non-point source impacts). Impacts to habitats near cultivated land can range widely depending on the specific crop and farming practices. Practices such as no or low-till farming allow all or some crop residue to remain on the land, reducing soil erosion and sedimentation. Crop rotation and contour farming improve soil quality and crop productivity. Organic farming and integrated pest management eliminate or reduce use of agricultural chemicals, thus their runoff into nearby streams, rivers and lakes. These are but a few of a plethora of farming techniques evolving under the umbrella of "sustainable agriculture" and "whole farm planning" that reduce the ecological impacts of agriculture[36]. A number of Canadian and U.S. federal, state and provincial programs have been developed to encourage farmers to adopt practices that provide some conservation and/or habitat value[37]. Programs under the U.S. Farm Bill to promots conservation of agricultural lands are discussed in Section VI. A. 6. Programs for Private Landowners.

The impacts from cultivated land are a much greater issue on the Canadian portion of the Lake St. Clair coastal habitat project area due to the greater amount of land dedicated to agriculture. As of 2000, 77.6 percent of the Canadian side of the project area is cultivated land, while only 16.6 percent of the U.S. project area is cultivated land[38].

Another form of agriculture, animal husbandry, generally has some distinct ecological impacts. Land clearing is still an issue, but depending on the type of animal, the farming operation may actually require much less land. Chemical runoff diminishes with little need for pesticides, but the ecological impacts on and off-site from nutrient runoff are generally far greater and the main source is manure. Over the past several decades, the livestock and poultry industry has become more concentrated, developing into fewer and larger operations. These operations, known as Confined Animal Feeding Operations, or CAFOs, raise concerns over the use and disposal of animal manure. When used as a fertilizer, manure can produce valuable nutrients for crop and pasture growth. However, these same nutrients can pollute the water resources, and degrade or destroy aquatic habitat through runoff when too much is applied to the land. Such is often the case with CAFOs. Since 2002, under rules developed by the U.S. Department of Agriculture and the U.S. Environmental Protection Agency, CAFOs in the U.S. are required to obtain a permit, show that they are not discharging waste into surface waters, and also develop and implement a nutrient management plan[39].

HIGHLIGHT

Broader implementation of sustainable agricultural practices and whole farm planning can help offset the impacts of producing food and fiber and improve the relationship between habitat and agriculture.

Notwithstanding impacts, agricultural land uses are perhaps the least damaging form of development and the most reversible. Once land is paved over and built upon, there is very little chance of that land reverting to any sort of natural vegetative cover that can provide a quality habitat. Agricultural lands, on the other hand, provide the future possibility of habitat, by simply reverting to a natural state over time. Although it may not be particularly high quality habitat if left on its own, it has the potential to provide quality habitat through restoration. Programs under the U.S. Farm Bill to promote conservation on agricultural lands are discussed in Section VI. A. 7.

Broader implementation of sustainable agricultural practices and whole farm planning can help offset the impacts of producing food and fiber and improve the relationship between habitat and agriculture. Additional incentives and rewards are needed for farmers. Governments at all levels can augment education and outreach to the farming community and vice-versa so that policy is responsive to and reflects actual field experience.

V. A. 6. Soil Erosion and Sedimentation

Erosion is the detachment of soil particles by wind, rain and other forces. Sedimentation is the deposition of soil in streams, bays, wetlands and harbors, after it has eroded off of land. Impacts of soil erosion are diverse and are influenced by complex hydrological, physical, chemical and biological factors While erosion and sedimentation are natural processes, the rates at which they occur have accelerated due to human activities.

Sediment is made of different sized particiles which contain a combination of different minerals, bacteria types, and other organisms and may also include man-made chemicals, such as fertilizers and pesticides that bind to are bound to the soil particles

HIGHLIGHT

Increased erosion and sedimentation are directly related to land-use changes or to poor land management.

Erosion and sedimentation can negatively impact the health and function of stream channels. Changes in the balance between flow and sediment load can alter channel size and configuration, and consequently alter the system's hydrology[40]. Erosion and sedimentation can also degrade or destroy the aquatic habitat in rivers and streams (e.g., increased turbidity, reduced light penetration, increased temperature, reduced productivity, the elimination of pools and riffles necessary for spawning and feeding) as well as the species that inhabit them (e.g., gill abrasion, egg abrasion, reduced bivalve pumping rates, and direct mortality).

Increased erosion and sedimentation are directly related to land-use changes or to poor land management. This is a regular occurrence in agricultural areas, where many farmers must plow the soil to plant seeds. It can also occur when vegetation is removed for construction of new roads and buildings. Clear-cutting of forests can also expose soil to erosion, as can forest fires. This dislocated soil is then transported by wind and water. Some of this dislocated soil is deposited in ditches and stream channels, while the remainder passes through the system and contributes to the "sediment yield" or the total sediment that leaves a drainage basin (usually measured in tons/acre/year).

GAP

There are no precise measurements for how much soil is eroding in the watershed and being deposited in Lake St. Clair and information on sediment transport and yield is lacking.

Unfortunately, there are no precise measurements for how much soil is eroding in the watershed and being deposited in Lake St. Clair and information on sediment transport and yield is lacking[41, 42]. The only comprehensive soil erosion data available for the Great Lakes region, the National Resources Inventory (NRI), is only for agricultural lands and it is likely that a significant amount of sediment in Southeastern Michigan is eroding from developed areas. The NRI data demonstrates that regional and national erosion and sedimentation rates have declined over the past twenty years, yet appear to have leveled off in recent years with little change since 1992[43].

Lake St. Clair wetlands are highly sensitive to river flow and lake level fluctuations, which make understanding sediment transport, deposition, and resulting impacts particularly important[44]. Several key programs that address soil erosion and sedimentation are described below.

County Conservation Districts provide assistance to local landowners, organizations and governments to address natural resource issues. They provide technical assistance, conduct education and outreach, and implement conservation practices for soil erosion and sediment control. The Environmental Quality Incentive Program (EQIP), which was discussed in the previous section, provides resources for farmers to address problems with soil erosion and sedimentation.

The Great Lakes Basin Program for Soil Erosion and Sediment Control is a federal/state partnership designed to coordinate the efforts of the various levels of government on soil erosion and sediment control activities. The Basin Program (*www.glc.org/basin*) provides grants for program and technical assistance, demonstration and education projects. The Great Lakes Commission coordinates the Program, in partnership with the U.S. Department of Agriculture (National Resources Conservation Service), the U.S. Environmental Protection Agency and the U.S. Army Corps of Engineers.

HIGHLIGHT

It is not necessary to know exactly how much erosion is occurring to experience the impacts, or to prevent erosion and sedimentation. Greater effort is needed to apply existing programs and tools to reduce the impacts from land development and land use practices.

The U.S. Army Corps of Engineers is currently developing a sediment transport model for the Clinton River watershed to predict the amount of surface runoff and sediment that is being delivered to the river. The Macomb County Office of Public Works is also conducting a study on how land use changes over time have affected the geomorphology of the Clinton River. These models could be applied to a number of current planning efforts in the watershed, including Phase II stormwater permits, Total Maximum Daily Loads (TMDL), spill response and water quality modeling.

V. B. Altered Hydrology

A variety of habitat stressors can be classed under the general heading of altered hydrology; these stressors include filling and draining wetlands, dredging and regulation of water levels. Activities such as draining, dredging, diking and filling have modified the natural flow regime of Lake St. Clair, particularly in the delta, which has been extensively diked.

HIGHLIGHT

Activities such as draining, dredging, diking and filling have modified the natural flow regime of Lake St. Clair, particularly in the delta, which has been extensively diked.

All of these activities are regulated at the Federal level under Section 404 of the Clean Water Act (CWA) of 1972. Under this section, the U.S. Army Corps of Engineers (ACOE) is granted principal permitting authority, although the U.S. Environmental Protection Agency (EPA) is authorized to veto permits issued by the Corps for filling of wetlands. Michigan is one of two states that have authority to administer section 404 of the CWA, and its Department of Environmental Quality (MDEQ) shares jurisdiction with the Corps in some areas. State regulations that support the provisions of section 404 of the CWA are found in Part 303, Wetlands Protection, of the Natural Resources and Environmental Protection Act (NREPA), PA 451 of 1994, as amended[45]. Some wetlands in coastal areas are given further protection under Part 323, Shorelands Protection and Management, of NREPA.

In spite of improved wetland protection laws in the United States, isolated wetlands that are smaller than five acres are not protected. This gap in regulations has allowed the piecemeal conversion of wetlands to urban and agricultural uses and continues to pose threats to fish and wildlife habitat. A local unit of government has the authority to create wetland regulations that address wetlands not protected by the state, by implementing wetland ordinances. Wetland ordinances and other planning tools will be discussed in more detail in Section VI. C. Local planning tools for protecting habitat.

GAP

Wetlands smaller than 5 acres are unprotected by U.S. federal and state law and ther is no specific legislation to protect wetlands in Ontario. Local wetland ordinances are critical to protect and unregulated wetlands.

There is no specific wetlands legislation in Ontario or Canada. In Ontario, wetlands receive indirect protection through Ontario's Planning Act, Fish and Wildlife Conservation Act, Environmental Assessment Act, and Ontario Water Resources Act, among other legislation. However, other legislation, such as the provincial Drainage Act, still works against wetland conservation by permitting wetland drainage for agricultural purposes. At the federal level, the Canada Wildlife Act, Fisheries Act, Migratory Birds Convention Act, and Canadian Environmental Assessment Act provide some protection to wetlands through species and habitat conservation measures. Most often, wetlands are protected through policies and agreements. While certainly valuable, these vehicles do not have the same clout as legislation.

Wetland Permits in the US

A joint state and federal permit process has been established between the MDEQ and the U.S. Army Corps of Engineers (ACOE) for proposed projects in areas which have both state and federal jurisdiction. The MDEQ's Land and Water Management Division will determine whether a permit application requires joint state and federal review, and when appropriate, will forward these permit applications to the COE Detroit office for federal permitting review[46].

Permits are required for the following activities:

- Depositing or permitting the placement of fill material in a wetland
- Dredging, removing or permitting the removal of soil or minerals from a wetland
- Constructing, operating or maintaining any use or development including dikes, seawalls and docks in a wetland or (cont.)
- Draining surface water from a wetland

Wetlands and shorelines are regulated if they if they fall into any of the following categories:

1) connected to one of the Great Lakes or Lake St. Clair;
2) located within 1,000 feet of one of the Great Lakes or Lake St. Clair;
3) connected to an inland lake, pond, river, or stream; located within 500 feet of an inland lake, pond, river or stream;
4) Not connected to one of the Great Lakes or Lake St. Clair, or an inland lake, pond, stream, or river, but are more than 5 acres in size and located in counties with a population of more than 100,000; or
5) not connected to one of the Great Lakes or Lake St. Clair, or an inland lake, pond, stream, or river, and less than 5 acres in size, but the DEQ has determined that these wetlands are essential to the preservation of the state's natural resources and has notified the property owner[47].

V. B. 1. Water Level Changes

Natural fluctuations in water levels are an important part of the coastal area's ecological dynamic and productivity and are discussed in Section V. F. 5. Fluctuations can result in dramatic changes within Lake St. Clair's gently sloping marshes and lakeplain. Variable water levels create greater diversity among plants and animals that adapt to and depend on a highly changeable wetland environment. However, some changes in water levels are a result of explicit human intervention and tend to disrupt natural processes.

Human-induced changes in water levels are usually part of larger efforts to control and maintain desired levels of water for specific purposes. Human control of the outflow of Lake Superior affects water levels in the lower Great Lakes, including Lake St. Clair. The marshes of Walpole Island First Nation, parts of the St. Clair Flats areas in the delta, and much of the eastern shore of Lake St. Clair have been extensively diked; pumping stations and water level gauges have been installed so that water levels can be maintained at levels that are optimal for attracting and sustaining populations of game birds. Hunting and fishing are the foundation of Walpole Island First Nation's leading industry--recreation and tourism, and are significant revenue sources throughout the region. As such, management of these diked wetlands in a manner that can ensure their sustainability as an economic resource is of utmost importance.

In spite of their potential benefits, however, water levels that are artificially maintained at a constant level interrupt natural fluctuations that are beneficial to coastal

ecosystems and result in negative impacts over the long term, particularly for natural communities such as lakeplain prairie, which require periodic flooding to persist. Water in shallow impoundments and drainage canals, when isolated from the flow of the Great Lakes, tends to have low oxygen levels and warms up rapidly, diminishing its value as habitat for fish and other aquatic organisms. Dredging in the St. Clair River is believed to have significant, yet temporary affect on water levels in the lake.[48]

V. B. 2. Draining

Wetland loss has been significant in both Michigan and Ontario and much of this can be attributed to the draining of wetlands for agricultural and urban development. Since 1873, over 70 percent of the wetlands have been lost on the U.S. side of Lake St. Clair, both for agriculture and urban development[49]. The Canadian portion of the watershed has experienced a similar loss of coastal wetlands. Between 1873 and 1968, much of this land was drained for agricultural and residential purposes. By the mid-1960s more than 40 percent of the wetlands directly associated with the lake were destroyed. By 1982, Kent County and its surrounding counties had lost 80-100 percent of their original wetland areas. Essex County lands draining to Lake St. Clair have lost over 97 percent of the wetland area and 95 percent of the original forests to agricultural and urban development[50]. Currently 92 percent of the Essex County lands are in agricultural use and 5 percent urban infrastructure with only 3 percent remaining as natural lands. The rate of conversion to agriculture has slowed in recent years, and some of the drained pasturelands and poorer cropland in the areas have been reflooded. While this allows some agricultural land to re-convert to wetland habitat, the quality of habitat provided by these wetlands is uncertain.

HIGHLIGHT

Since 1873, over 70 percent of the wetlands have been lost on the U.S. side of Lake St. Clair and the Canadian portion of the project area has experienced similar losses.

Wetland Mitigation Banking

Michigan and federal wetland permits typically require that wetland lost through development, be mitigated[51]. Mitigation may be accomplished through creation of new wetlands, restoration of existing wetlands, or acquisition of approved credits from a wetland mitigation bank. Wetland mitigation banking refers to the process of creating or restoring wetlands which are used to offset future authorized wetland fills in a watershed. In Michigan, wetland mitigation banking is regulated under the wetland protection part of the Michigan Natural Resources and Environmental Protection Act[52].

Wetland mitigation projects are most likely to succeed on sites that were historic wetlands as their soils and hydrology are most conducive to reestablishment. In a 1997 MDEQ study funded by the USEPA, it was determined that the vast majority of mitigated wetland sites did not provide the ecological functions of the wetlands that they replaced. Only 22 percent of the projects studied were considered successful overall[53].

Successful wetland mitigation can be extremely expensive; although historic wetlands can be restored and monitored for as little as $5,000.00 US per acre, the average cost of a created wetland is $40,000.00 US per acre, not including the cost of the land[54]. Beyond the costs involved, however, and the mixed track record of mitigation projects, high quality wetlands simply cannot be recreated and their preservation is imperative.

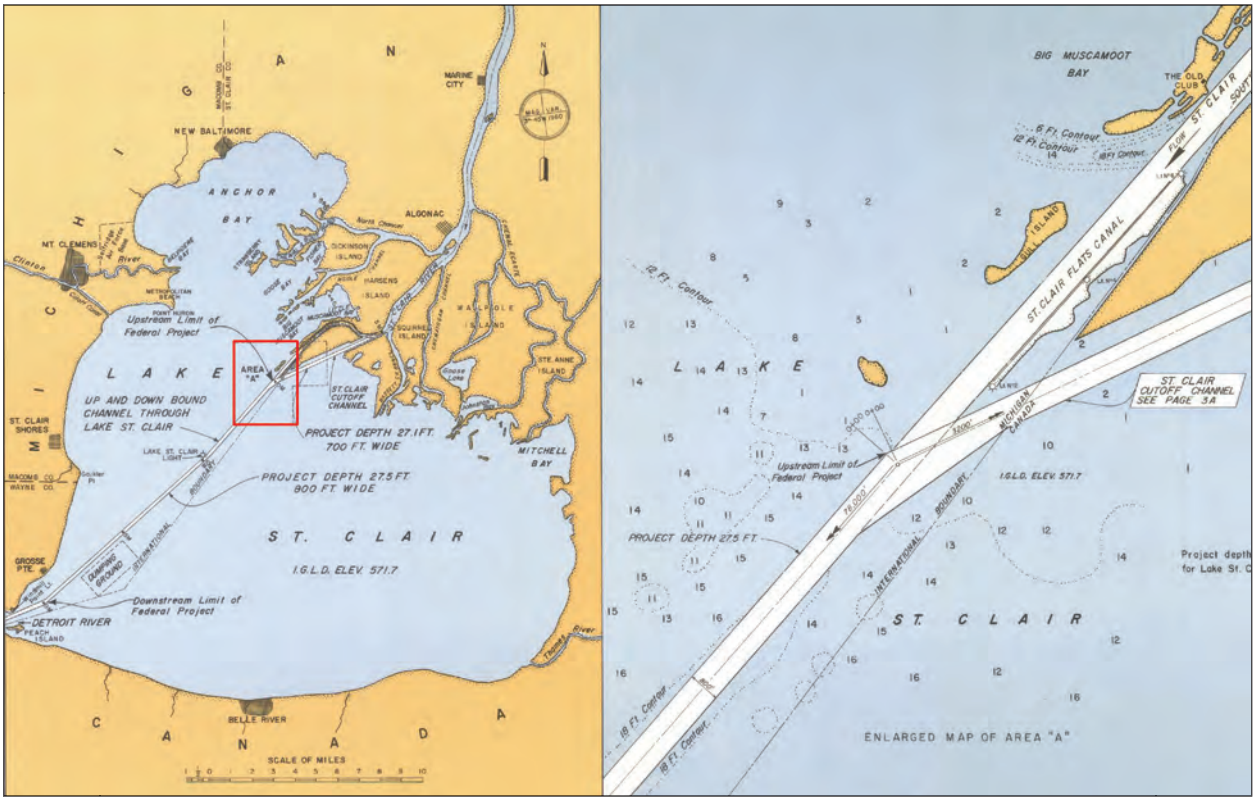
V. B. 3. Filling and Dredging

Filling has severe effects on wetland areas, completely destroying them and eliminating all their beneficial functions[55]. Filling occurs primarily in developing areas as wetlands are converted to urban (residential, commercial, and industrial) uses. Although wetlands larger than five acres are protected, parcels smaller than five acres have been routinely filled. Filling often accompanies dredging, where accumulated sediments are removed from the bottom of waterways to maintain adequate depth for safe and efficient vessel operations. Dredged material that is removed must go somewhere and too often in the past it was used to fill wetlands.

Dredging of the St. Clair River is shown to have permanently lowered the levels of lakes Huron and Michigan by almost 1 foot (27 centimeters)[56]. Dredging of the navigation channel in the Lake St. Clair itself is known to alter water levels in the lake, but only temporarily[57]. Maintenance of the Lake St. Clair navigation channel has been authorized by the U.S. Congress numerous times, with the first record of authorization going back

to 1886. Dredging to maintain the Lake St. Clair navigation channel (and all U.S. commercial navigation channels on the Great Lakes) is done by the U.S. Army Corps of Engineers. The navigation channel bisects Lake St. Clair in a north-east-southwest direction between the St. Clair Delta and the Detroit River.

The current U.S. Congressional authorization provides for an improved channel 800 feet wide and 14.5 miles long in Lake St. Clair that extends from the lower end of the Southeast Bond Cut-Off Channel in the St. Clair River to the Detroit River, all to a depth of 27.5 feet[58]. This dredging increased the lake's maximum natural depth of 21 feet (6.4 meters) to its current depth of 27.2 feet (8.3meters).



Outside of commercial navigation channels, dredging of lake bottoms is also considered as a remedial technique to remove excess sediment, increase lake depth for recreational boating, or remove toxic or nutrient-rich sediment from the lake environment. Dredging has impacted the St. Clair River and Lake St. Clair system by redirecting how the water moves through the system. Dredging temporarily increases turbidity in the lake which can lead to environmental degradation. The sediment may be a nutrient sink and dredging may reintroduce the nutrients back into the lake. Dredging also replaces productive shoal-water habitat with less productive channel habitat. The disposal of dredged material can be a problem, especially if the sediment is contaminated. Together, dredging and filling can completely destroy marshes and impact adjacent marshes by increasing sediment loading, reducing habitat diversity, altering natural flow patterns, and changing nutrient regimes and plant communities[59].

V. B. 4. Diking and Breakwalls

Dikes and breakwalls are often constructed to reduce flooding and erosion along the Great Lakes shoreline and to protect residential areas, cottages and agricultural lands from ship or boat wakes. In the St. Clair Flats region, construction and maintenance of a complex network of dikes permits the control of water levels in the delta to attract and sustain waterfowl populations for hunting, wildlife viewing and related recreation. These structures have a diverse array of impacts on the coastal habitat. They reduce the natural sediment supply that nourishes wetland communities, interfering with sediment processes that maintain wetlands[60]. Hard shoreline structures can shift wave energy and increase ero-

HIGHLIGHT

Construction and maintenance of a complex network of dikes permits the control of water levels in the delta to attract and sustain waterfowl populations for hunting.

sion rates in other parts of the coastal zone. They can restrict the landward movement of wetland communities during high water periods, causing a "backstopping" effect that reduces the size and diversity of wetland communities[61]. Shoreline modifications can also impact wildlife communities as they isolate wetlands from natural interactions with upland communities[62]. For more information on shoreline modification, see Section V. D. 2. Shoreline Hardening.

V. C. Contaminants

A variety of contaminants act as stressors within the project area, ranging from obvious toxins such as polychlorinated biphenyls (PCBs), polynuclear aromatic hydrocarbons (PAHs), lead, and mercury, to excess nutrients and pesticides.

HIGHLIGHT

Excessive nutrient loading can result in potentially harmful algal blooms that lead to oxygen declines, an imbalances among aquatic species, public health threats and a general degradation of the aquatic resource.

V. C. 1. Nutrient Loading

Nutrients - in particular nitrogen and phosphorous - occur naturally in the environment and are essential building blocks for plant and animal growth. Excessive nutrient loading, however, can result in the accelerated growth of macrophytes or phytoplankton, potentially harmful algal blooms that lead to oxygen declines, imbalances among aquatic species, public health threats and a general degradation of the aquatic resource . Nonpoint sources are the primary cultprit of excessive nutrient loadings into Lake St. Clair and include agricultural runoff, eroded soils, urban stormwater runoff and wastewater runoff. Point sources of concern include quarries, mines and industrial and municipal discharges. Research has shown that the key factors that cause eutrophication - or over-enrichment - of waterbodies are excessive concentrations of the primary nutrients phosphorus and nitrogen[64].

A primary source of excess nutrients is agriculture[65]. While proper application of nutrients produces healthy crops, lack of buffers, over-fertilization and misapplication can contribute to water quality problems. In Ontario, approximately 75 percent of the land in the Lake St. Clair watershed used for farmland[66], while agriculture is estimsted to account for only 32 percent of the watershed on the U.S. side.[67] (See Section IV. A. for a discussion of agriculture in the project area.)

CASE STUDY

CURB - Clean up Rural Beaches

The St. Clair Region Conservation Authority's Clean Up Rural Beaches (CURB) studies identified manure as Ontario's second largest pollution contributor to Lake St. Claor after faulty septic systems. Implementation programs to reduce livestock access to watercourses, correct pollution sources and improve local water quality followed the CURB studies. Several soil and water conservation programs, such as Healthy Futures and the Great Lakes Sustainability Fund, encourage the use of Best Management Practices to improve local water quality and habitat. The new Ontario Nutrient Management Act is expected to enhance water quality by improving the use and handling of manure and other fertilizers and requiring buffers adjacent to watercourses.

Manures and chemical fertilizers are the primary sources of nutrients from agriculture. Manure can contaminate streams and waterways through the spread of manure on fields, runoff from manure storage and by allowing cattle to access streams where their waste can be directly deposited into the water. Livestock facilities can also release wastes. Manure spills are reported to have caused more fish kills in Ontario between 1988

and 2000 than all other types of spills. Nutrient management and best management practices for manure handling and spreading are critical to maintaining healthy watersheds.

GAP

Research is needed to document the impacts of CAFO's on water quality.

Another concern is the increasing trend on both sides of the border toward Concentrated Animal Feeding Operations (CAFOs)[68]. Traditionally, manure, litter, and wastewater produced at animal feeding operations have been applied to cropland as fertilizer. The growing number of CAFOs and the increased amount of agricultural waste has resulted in nutrients that exceed crop needs. It is unclear to what extent CAFO waste contributes to water quality degradation and research is needed to document its impacts[69].

Urban areas discharge nutrients to the environment as well. Excessive use of fertilizers is a major source of nutrients from golf courses and urban homeowners. F Urban homeowners can typically apply many times the amount of fertilizer needed to support their lawns or gardens. The excess fertilizer runs off the property, flows into sewer systems and accelerates plant growth downstream. Natural wetlands can remove some nutrients from storm water runoff but development has reduced these natural filtration areas, increasing the nutrient loads to the region's habitat.

FACT

Urban homeowners can typically apply many times the amount of fertilizer needed to support their lawns or gardens. The excess fertilizer runs off the property, flows into sewer systems and accelerates plant growth downstream.

Other urban nonpoint sources include combined sewer overflows (CSOs), sanitary sewer overflows (SSOs), failing onsite sewage disposal systems (OSDSs, also known as septic systems) and discharge from municipal and industrial wastewater treatment plants, which can all contribute excess nutrients to the region's water bodies. The primary concern about these sources is bacteria loadings that can impact human health as well as aquatic communities.

Excess nutrient loadings from improperly treated stormwater and sewage, illicit sewer connections and stormdrains, and failing septic systems are thought to have been the catalyst for the large floating mats of submersed aquatic vegetation found along the western shoreline of Lake St. Clair in 1994.[70] At that time, an estimated 500 million gallons of improperly treated stormwater and sewage were discharged into Lake St. Clair from five CSO basins[71] (Jaski 1994).

The U.S. EPA's National Nutrient Strategy[72] is an effort to reduce and prevent nutrient overenrichment of water bodies on a national scale (USEPA, 1998). The strategy requires each state to complete a plan for developing and adopting nutrient criteria into water quality standards. The Michigan Department of Environmental Quality developed and submitted a Nutrient Criteria Adoption Plan for Michigan's surface waters to the USEPA in January 2002. In addition, Michigan is required to determine the Total Maximum Daily Load (TMDL) of nutrients for watersheds that are impaired by excess nutrients. Proper TMDL calculations will require accounting for nutrients derived from all sources, including agriculture, and may lead to mandated reductions of agricultural loadings.

Recently, Ontario has established legal requirements for the storage and handling of manure and other nutrients. The new Ontario Nutrient Management Act is expected to improve water quality by improving the use and handling of manure and other fertilizers and requiring buffers adjacent to watercourses. The Act provides a framework for setting clear consistent standards for nutrient management on farms. It is enabling legislation that supports the development of regulations for nutrient management and other related farm practices. One of the most important features of the Act is the requirement for farms to prepare nutrient management plans and nutrient management strategies. Through

the General Regulation under the Act, farmers are required to prepare Nutrient Management Strategies and/or Nutrient Management Plans.

Canada also has several soil and water conservation programs, such as Healthy Futures, Environmental Farm Plan and the Great Lakes Sustainability Fund, that encourage the use of Best Management Practices to improve local water quality and habitat.

There is a lack of research on the effectiveness and benefits of BMPs to reduce nutrient loadings[73]. Specific needs include: 1) Research on the changes in nutrient transport to receiving waters due to specific BMPs or combinations of BMPs. 2) Evaluations of BMP effects on nutrient concentrations and discharges are needed at the farm and watershed scale. 3) Specific BMPs for the management of nutrients to protect water quality need development and refinement. 4) Tools for developing farm nutrient management plans based on nutrient budgets.

V. C. 2. Toxic Contamination

While the passage of stringent laws and regulations have led to declines in discharges of toxic chemicals, many still persist in the system and are available to plants, fish and wildlife. Examples of toxics of concern in coastal Lake St. Clair include polychlorinated biphenyls (PCBs), Hexachlorobenzene (HCB), organochlorines (OCs), polynuclear aromatic hydrocarbons (PNAs), mercury and lead. These contaminants enter the system through a variety of pathways, including both point and nonpoint sources.

HIGHLIGHT
While the passage of stringent laws and regulations have led to declines in discharges of toxic chemicals, many still persist in the system and are available to plants, fish and wildlife.

Toxic contaminants can have lethal and sublethal effects on fish and wildlife, affect species reproduction, impact the food supply, degrade habitat and affect overall ecological productivity[74]. Because such contaminants become more concentrated as they move up the food chain through the processes of bioaccumulation[75] and biomagnification[76] they have the greatest impact on animals at the top of the food chain, such as predatory birds, fish, and mammals[77, 78, 79, 80, 81, 82, 83, 84]. Some of the effects that have been documented include thinning of egg shells and deformities among Great Lakes birds that prey on fish, and lower hatching success and increased deformities in snapping turtles.

The long-term effects of toxic chemicals on plants are not as well understood[85]. Studies have shown that herbicides can alter planktonic species composition and inhibit photosynthesis of aquatic plant communities[86]. However, recent studies have shown that these damaging impacts may be short-term and reversible[87]. More permanent effects may occur in areas receiving large amounts of agricultural runoff with little dilution, such as barrier beach wetlands[88]. Road salt runoff is also a concern as it has been shown to alter algal, macrophyte and faunal communities of wetlands[89].

Both point and nonpoint sources of pollution contribute toxic contaminants to the environment. Point sources include industrial discharges, effluent from municipal wastewater treatment plants and waste disposal sites. Point source discharges from industry are generally well regulated in the study area[90, 91], but have the potential to stress the environment if there is an accidental spill[92], runoff or leakage, or due to cumulative impacts of low levels discharges over time.

Accidental spills along the St. Clair River corridor have been a problem in the past. However, the number and size of spills or releases has reduced dramatically over the last several years due to measures implemented by both U.S. and Canadian industries. On-going monitoring must continue to assure that the number of spills and the quantity of materials spilled continues to decline.

CASE STUDY
Pesticides in Lake St. Clair

The U.S. Geological Survey recently investigated the distribution of pesticides in the Lake Erie-Lake St. Clair watershed as part of its National Water Quality Assessment Program (NAWQA). Concentrations in streams were in the top 25 percent in the nation and many public water supplies must treat water to reduce herbicide concentrations. The pesticides detected most frequently were among those applied in the greatest quantities to agricultural and mixed land use areas. Atrazine, acetochlor, cyanizine, metolachlor, and simazine were detected in 50 to 100 percent of samples.

Other point sources, such as municipal wastewater treatment plants and waste disposal sites are also a concern. Municipal wastewater treatment plants may discharge low levels of metals and organic pollutants from treated industrial waste and household chemicals. Even when in compliance[93] with regulated guidelines, these facilities can contribute substantial loads into the Lake St. Clair system over time. Though well regulated, waste disposal sites are also a suspected source. Historic dumping sites and abandoned landfills, which are not well regulated, could also be a source of toxic contamination.

Nonpoint sources of chemicals include runoff containing pesticides and other chemicals, contaminated sediments and airborne deposition. Airborne deposition, is also a nonpoint source of contaminants, particularly mercury. Airborne deposition directly to the St. Clair River represents a minor source because of the small surface area relative to its very large flow although inputs from Lakes Huron, Michigan, Superior and their watersheds could be significant due to their large surface area. Due to their nature, nonpoint sources are more difficult to regulate and in many areas are believed to be the primary source of current contamination.

HIGHLIGHT
Environment Canada and the U.S. EPA are working toward a goal of virtual elimination of persistent toxic substances resulting from human activity.

The Great Lakes Binational Toxics Strategy (the Strategy)[94] provides a framework for actions to reduce or eliminate persistent toxic substances, especially those that bioaccumulate, from the Great Lakes basin. Pursuant to the Great Lakes Water Quality Agreement Environment Canada and the U.S. EPA, (in consultation with other federal departments and agencies, Great Lakes states, the Province of Ontario, tribes and First Nations), are working toward a goal of virtual elimination of persistent toxic substances resulting from human activity. While this is the long-term objective, the current focus is on a framework that will achieve specific reductions through 2006.

V. C. 3. Sediment Contamination

The United States Environmental Protection Agency estimates that of the 12 billion cubic yards of surface sediments (the first five centimeters of sediments) which lay within the United States, ten percent, or 1.2 billion cubic yards, of these sediments are contaminated to levels at which there is potential risk for aquatic organisms. They also estimate that between 3 million and 12 million cubic yards of dredged material are also contaminated[95].

HIGHLIGHT
Areas of Concern around Lake St. Clair are important sources of contaminated sediments that impair beneficial uses of the Lake and compromise aquatic health.

The Areas of Concern (AOC) around Lake St. Clair (St. Clair River, Clinton River and Detroit River) each have elevated levels of pollutants in the sediments that impair the beneficial uses of those areas[96] and where aquatic health has been compromised. (Figure 1.)

The Upper Great Lakes Connecting Channels have reports of elevated organochlorine compounds, polycyclic aromatic hydrocarbons and trace metals (Table 1.). The highest levels of the organochlorines, total

chlordane, total DDT, total hexachlorocyclohexane and lindane for the entire Lake Erie – Lake St Clair drainage area are in the Clinton River or at its mouth. Lake St Clair also has elevated organochlorines. PCBs are at least 10 times the probable effect level (PEL) at the center of Lake St Clair near the dredged channel cutting across the lake[98]. (Rheaume, 2000)

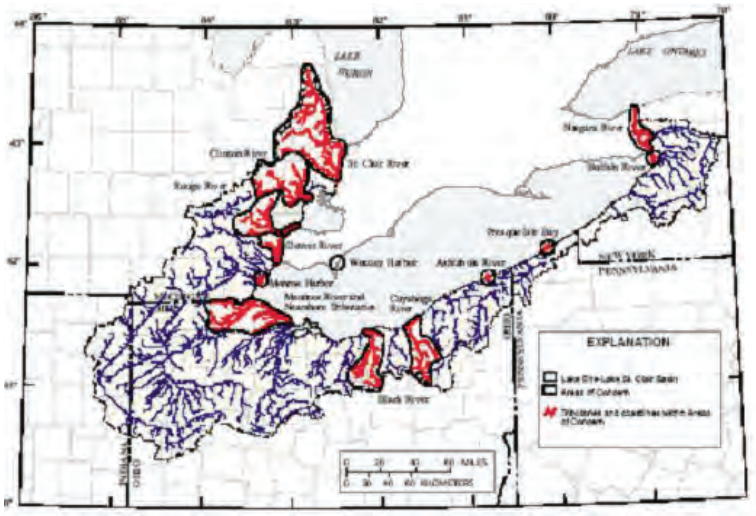


Figure V C 3 - 1
Areas of concern are spread throughout the Lake St Clair – Lake Erie basin. Areas of concern are shown in red[97].

Polycyclic aromatic hyrdrocarbons (PAHs) are also common in the sediment of Lake St Clair's tributaries. In the upper Clinton River the PAH levels were 138 to 171 times the Probable Effect Level (PEL). The main stem of the Clinton River and the Detroit River had elevated levels greater than 10 times the PEL. Anthracene and Benz[a]anthracene also exceeded PEL in the sediments of the Clinton and Detroit Rivers. Benz[a]pyrene is elevated so high that it is 11.9 to 141 times the PEL in the sediments of the Clinton and Detroit Rivers. Chrysene was found between 10.1 and 209 the PEL in sediments of the Detroit and Clinton Rivers. Phenanthrene was found at 10.1 to 1165 times the PEL[99].

FACT
PEL = Probable Effect Level
TEL = Threshold Effect Level
These sediment quality guidelines are used to calculate a hazard quotient by comparing concentrations of a contaminant at a site with concentrations that are associated with/cause adverse effects on aquatic biota (Smith 1996).

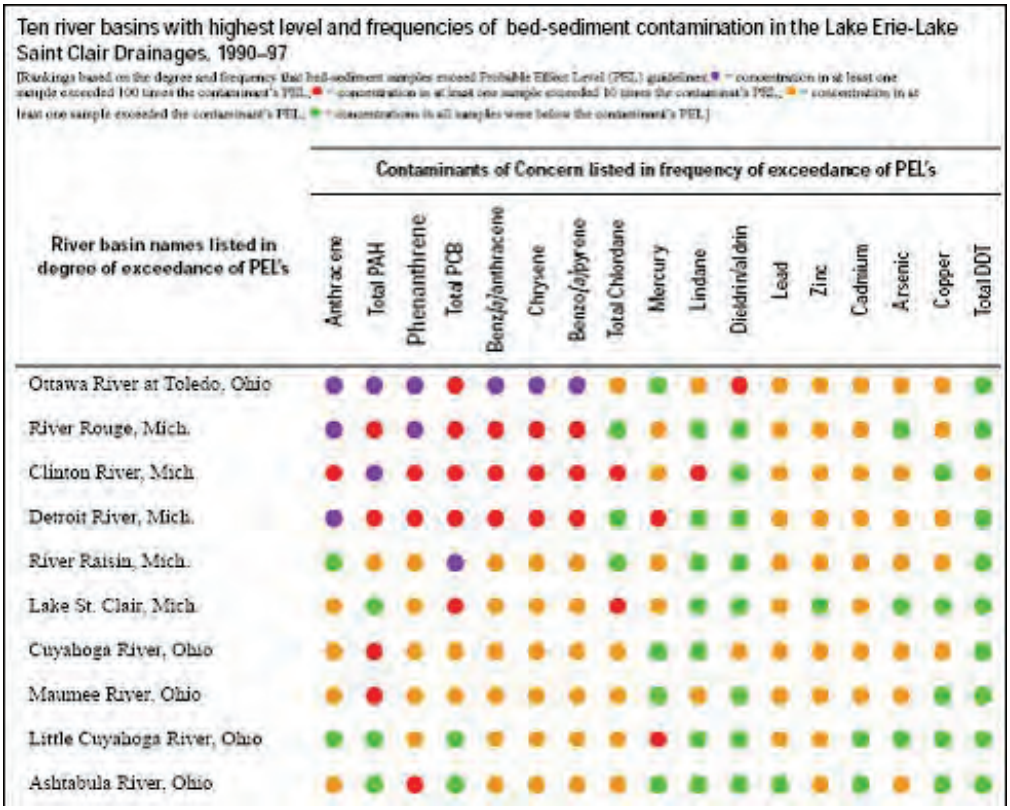
Trace metals are also found in abundance. Arsenic, cadmium, copper, and zinc were all found in the sediment of Lake St Clair and its tributaries. Cadmium was found at the highest levels in the Clinton River sediment at 7.9 the PEL. It also exceeded PEL in the main body of Lake St Clair. Copper was found in sediments in Lake St Clair and at the mouth of the Clinton River between the Threshold Effect Level (TEL) and PEL or in smaller amounts then the TEL. Zinc exceeded PEL in the Clinton River sediments[100].

Lake St Clair sediment has moderately elevated levels of copper, nickel, zinc, chromium, cobalt, volatile solids and phenol. Mercury and cyanide are found at especially high levels. Mercury was concentrated as high as 2.71 mg/kg (Figure 1.) and cyanide as concentrated as 0.6 mg/kg, however, it should be noted that in virtually every sample where cyanide was present, it was at or smaller than the calculated limit of detection of 0.1 mg/kg. The Environment Canada and Great Lakes sediment guidelines show the threshold effect and probable effect levels for mercury at 0.174 mg/kg and 0.486 mg/kg respectively. The USEPA considers values of cyanide greater then 0.1 mg/kg as toxic[101].

The elevated levels of sediment contaminants have been shown to have high potential costs[103]. Sediment contaminants can cause disease in aquatic organisms including tumors, fin rot and the loss of species and communities. These sediments can also poison the food chain through biomagnification resulting in high concentrations of toxics in predator fish. Societal costs include the loss of recreational fisheries, revenue from polluted areas and even worse – potential long term health effects such as cancer or neurological damage and IQ impairment to children[104].

Table V C 3 - 1

The Clinton and Detroit Rivers have some of the highest concentrations of pollutants, most several times the Probable Effect Level (PEL), in the region. (Rheaume, 1990-1997) Ten River basins with the highest level and frequencies of bed-sediment contamination in the Lake Erie – Lake St. Clair Drainages, 1990-97.



Remediation plans primarily include the removal of contaminated sediments and improved wastewater treatment, but are also beginning to address non-point source pollution, habitat restoration and pollution prevention among others. The cost of this remediation is estimated to be $7.4 billion dollars (USD) for the removal of toxic sediments and the improvement of wastewater infrastructure[105]. The United States approach to raising funds for the clean up is to target the primary polluters of the AOC when possible and require these groups to pay for the costs of remediation. When this is impossible, funds must be obtained from elsewhere. Within the Lake St Clair – Lake Erie corridor, $1 billion dollars (USD) has been spent to assist in upgrading the waste water treatment infrastructure. The major hurdle pre-

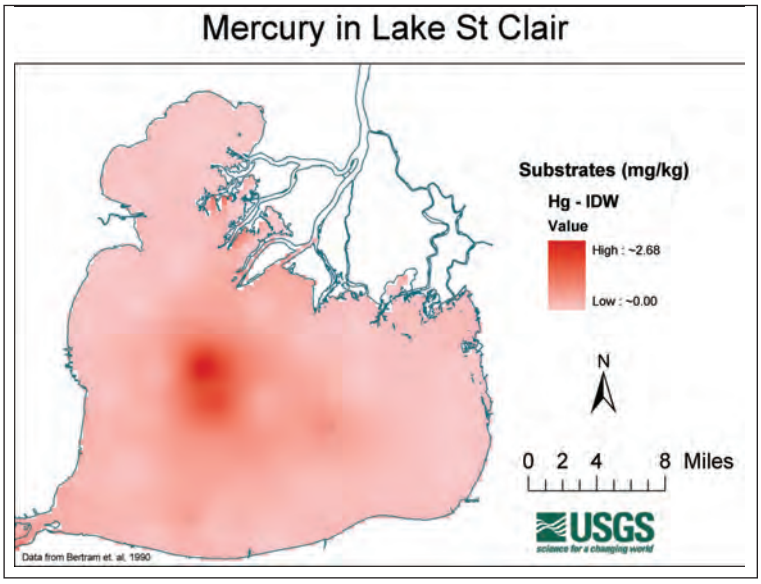


Figure V C 3 - 2

Interpolation using inverse distance weighted shows the distribution of mercury contaminants in silty sediments around Lake St Clair as being extreme in the center of the lake. The Environment Canada and Great Lakes Guidelines show levels greater then .171 mg/kg to be above the threshold effect level (TEL), and levels greater then .486 mg/kg at being above the probable effect level (PEL)[102].

venting progress for many AOC's is that the high costs have not been supported[106]. (See Section VI for more discussion on AOCs and remediation efforts.)

V. D. Shoreline Modification, Shipping and Boating

Much of the Lake St. Clair's region's appeal, both historically and today, is derived from its extensive shoreline and access to the rest of the Great Lakes system, as well as its proximity to urban centers. At the same time, this position has also subjected it to a number of stressors: shoreline development, both residential and commercial, with the attendant shoreline modifications, physical alterations to the lake itself, to accommodate the shipping industry, physical stresses related to the passage of ships and the ecological impacts of one of the highest densities of recreational boaters in the entire Great Lakes.

V. D. 1. Vegetation Removal

Vegetation removal or "beach grooming" refers to the practice of removing vegetation from sandy beaches. This practice is utilized most frequently during low water cycles in the Great Lakes when bottomlands that are normally submerged in high water cycles are left exposed. Seed banks and root systems that have been dormant when fully submerged begin to germinate in the drier, often sandy soils[107]. However, these shoreline habitats where the vegetation re-emerges in low water cycles are actually coastal wetlands of the Great Lakes. The sandy soils, typically not associated with wetlands in the public consciousness, result from the constant wave action of the Great Lakes waters, limiting the accumulations of rich organic materials[108].

HIGHLIGHT

Beach "grooming" removes shoreline vegetation that emerges during low water levels, destroying its habitat function and value and increases shoreline erosion.

Potential environmental impacts from vegetation removal include:

- Higher beach erosion rates as vegetation is removed by discing or plowing.
- Limiting or eliminating coastal fish spawning and nursery habitat.
- Limiting or eliminating migratory waterfowl use of wetlands for habitat.

Low lake levels are a time of shoreline vegetation growth, strengthening the exposed coastal lands, when root systems grow deeper and stronger, helping to prevent shoreline erosion when levels again rise. During rain and snow melt, streams, rivers and the overland flow of water carry heavy loads of water through coastal wetland vegetation, which acts as a sponge, soaking up water and reducing flooding. Wetland vegetation also helps break down pollutants and protects clean water supplies[109].

Two species of perch, northern pike and walleye use coastal wetlands as spawning grounds and emergent wetlands[110] are made more important during lower lake level cycles. These fish can not reach the higher areas where they leave eggs during high flow regimes, so areas exposed by lower lake levels become their new nesting grounds. Migratory waterfowl utilize coastal wetlands for nesting, foraging and stopovers. Large populations of migratory waterfowl are year-round residents of Lake St. Clair.

In Michigan, vegetation removal is regulated by Michigan DEQ[111] under Part 303, Wetlands Protection, and Part 325, Great Lakes Submerged Lands, of the Michigan Natural Resources and Environmental Protection Act (NREPA), 1994 PA 451, as amended, which describes certain "beach maintenance activities" that may be carried out between the normal high water mark of the Great Lakes and the "current" water's edge (i.e., exposed bottomlands held in public trust by the State of Michigan) without a state permit[112]. These include:

- Manual or mechanized leveling of sand in areas that are predominantly free of vegetation. Property owners may spread sand that has eroded onto upland portions of their property on bottomlands. Alteration of natural lake shore contours is not authorized.
- Mowing of vegetation to a height of not less than two inches without disturbing soil or plant roots. Mowing is limited to the width of the riparian property or 100 feet, whichever is less.
- Small scale hand pulling of vegetation, except for threatened or endangered species.
- Grooming of the soil by raking the top four inches of soil to remove debris without disturbing or destroying plant roots. Debris may include dead vegetation, trash, zebra mussel shells and dead fish.
- Construction and maintenance of a temporary pathway directly to open water. Temporary pathways may cross swales with standing waters, but may not exceed six feet in bottom width. Paths must be constructed of sand and pebbles obtained from exposed unvegetated bottomlands.

V. D. 2. Shoreline Hardening

Of the 542 miles (871 km) of Lake St. Clair's shoreline within the project area, 31 percent is identified as riprap, retaining wall, harbor structure or breakwater according to Environment Canada. Nearly the entire U.S. shoreline, except the islands of the delta, is armored.

Hardening the shoreline eliminates the migration of nearshore sediments with changing water levels. Such modifications are often motivated by the desire to eliminate such migration. Their effect, however, also reduces the amount of fish habitat available, especially in relation to what would be available during high-water years. Usually, such modifications also straighten the shoreline. Because irregularities in the shoreline cause local variations in alongshore currents, which in turn cause local variation in substrate, straightening results in a loss of habitat diversity.

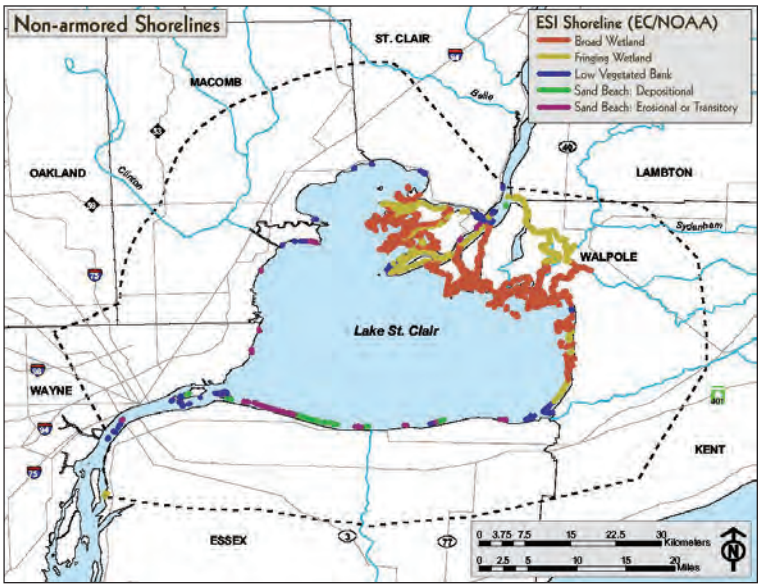


Figure V D 2 - 1
Shoreline armoring extent within the project area

Natural shores are nourished by material that has been eroded from other areas, becoming part of the littoral drift system. Attempts to reduce erosion by building shore protection structures, or armoring the shoreline in one area, have resulted in reduced littoral drift available, starving an adjacent area further down the coast.

HIGHLIGHT

Almost one third of the shoreline around Lake St. Clair is armored, including most of the U.S. shoreline, except for the delta.

Some of the physical processes linked to shoreline hardening are:

- beach area loss
- accelerated erosion of adjacent, unarmored property
- decrease in sediment supply to the beach
- increased wave energy seaward of armoring
- narrowing of dry beach area
- coarsening of existing beach material

Some of the biological processes linked to shoreline hardening are:

- burial or removal of habitat for bottom dwelling species due to shifts in beach material
- alterations in or complete loss of vegetative cover resulting in temperature fluctuations in shallow water
- loss of spawning, foraging and nursery habitat for fish due to alteration in the substrate
- loss of migratory corridor for fish caused by shifts in water elevation from existence of armoring
- decreased organic inputs due to loss of vegetation adjacent to the shoreline
- interruption of beach access to foraging wildlife

Although erosion is caused by natural shoreline processes, its rate and severity can be intensified by human activity. Wise management of shoreline construction and land uses can significantly reduce economic losses due to erosion.

Gently sloping beaches or wetlands along the water's edge are natural defenses against erosion. The slopes of the land along the edge of the water form a first line of defense called a berm, which dissipates the energy of breaking waves. During high water periods, a berm can prevent water from moving inland.

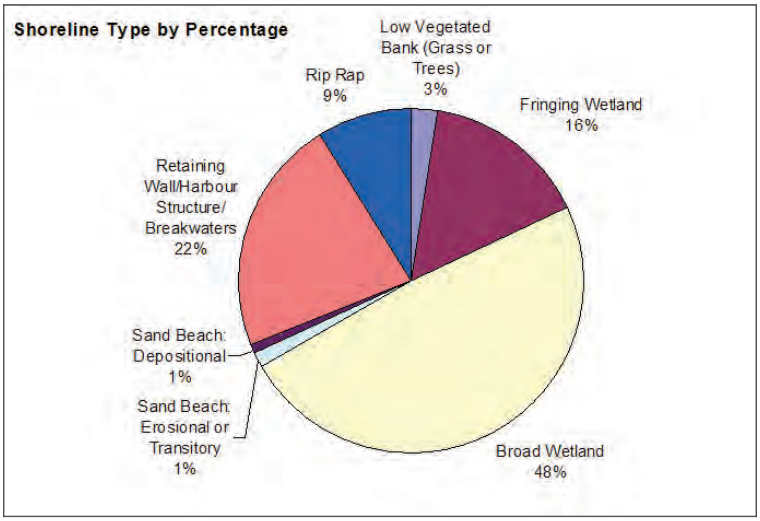


Figure V D 2 - 2
Lake St. Clair shoreline type by percentage

V. D. 3. Vessel Activity and Marina Development

Vessel activity in a confined, relatively shallow body of water such as Lake St. Clair is a known stressor of coastal habitat. Several environmental impacts result from the wakes of large or high-speed maritime vessels and anchoring. Wakes from large (e.g., Great Lakes/St. Lawrence Seaway bulk cargo carriers) or fast-moving recreational boats can cause erosion and vegetative damage in confined or shallow waters. Wakes can cause strong wave propagation that is capable of eroding shorelines or stirring up bottom sediments in shallow areas. Vegetation can be disturbed both by erosion processes and sedimentation resulting from wakes. Sedimentation reduces the amount of sunlight available for photosynthetic processes. The impacts of wakes are local in nature and likely to be more pronounced in confined, high traffic areas.

FACT

As a strategic connecting route on the Great Lakes/St. Lawrence Seaway System, Lake St. Clair's navigation channel sees from 4,000 to 5,000 vessel passages a year.

Lake St. Clair has a uniquely high combined traffic of both commercial cargo carriers and recreational craft. Commercial traffic includes U.S. and Canadian interlake vessels ("lakers confined to Great Lakes trades) of up to 1,000 feet long and 78,000-ton cargo carrying capacity, and oceangoing freighters of up to 740 feet in length and 36,000-ton capacity. As a strategic connecting route on the Great Lakes/St. Lawrence Seaway System, Lake St. Clair's dredged 59-foot wide, 27-foot deep commercial navigation channel sees from 4,000 to 5,000 upbound and downbound vessel passages a year.

The effect of passage of large commercial vessels on Great Lakes nearshore water habitat and biota has not been extensively studied but the areas of greatest concern are sections of the connecting channels where the vessels follow a dredged channel that occupies a large portion of the cross-sectional area of the connecting channel. In these areas, the

larger vessels fill much of the channel; as they pass, they sharply disrupt the normal water level and flow conditions. The change can be easily seen by watching the movement of water at the shoreline while a vessel passes. As the vessel approaches, its propellers cause a drawdown, pulling water towards the channel and dewatering shallow shoreline areas; then as the vessel passes, it creates a shoreward surge of water that floods the shoreline. During this drawdown and surge process, the direction of water flow at the shoreline rotates 360 degrees[113]. This water movement is believed to uproot or fragment submersed aquatic plants and to erode the low-density substrates that provide attachment for these plants[114, 115, 116]. A study in the St. Clair and Detroit Rivers revealed that the density and diversity of submersed aquatic plants was lower in the channels used by large commercial vessels than in the adjacent channels that were not used by such vessels[117].

Vessel passage in the connecting channels during the period of solid ice cover creates stronger drawdown and surge effects and stronger rotation of flow direction than during the ice-free period and can substantially increase the amount of living plants, decaying plants and benthic invertebrates that are swept from the shallow nearshore portions of the river bed into the main channel and then moved rapidly downstream as "drift"[118, 119, 120]. The accelerated transport of this material through the connecting channels in winter, when natural production of aquatic plants and animals approaches the annual minimum, represents a considerable loss of materials and energy that would otherwise be recycled in summer to produce useful plants and animals in these portions of the ecosystem.

Because of its excellent sport fishery and proximity to major U.S. and Canadian population centers, among other factors, Lake St. Clair also has one of the highest resident recreational boat densities in the Great Lakes. In the three Michigan counties fronting the lake alone, a 2002 study documented a total of 129,831 registered boats or about 590 boats per mile of U.S. shoreline on the lake and delta areas[121].

Lake St. Clair, portions of the connecting channels and certain other sheltered portions of the Great Lakes nearshore waters are important resting and feeding areas for migrating waterfowl[122, 123, 124]. Recreational boaters can flush and otherwise disturb flocks of resting and feeding birds, causing them to unnecessarily expend energy needed for migration, survival and reproduction. They can also force them to seek less favorable feeding and resting habitat or to alter their migratory schedules. To help relieve this stress, recreational boating is restricted seasonally in substantial portions of Lake St. Clair, which have been declared refuges for migrating waterfowl.

FACT

Lake St. Clair has one of the highest resident recreational boat densities in the Great Lakes. Recreational boaters can disturb flocks of resting and feeding birds, causing them to expend energy needed for survival and reproduction and/or them to seek less favorable habitat.

Supporting the robust recreational boating activity on Lake St. Clair is a substantial concentration of marinas. A 1994 study identified 211 on the U.S. side and another 13 on the less populated Canadian shores.

While there is little Lake St. Clair-specific data on the impact of marina development on coastal habitat, a study on the St. Lawrence River indicated that the construction of marinas, wharves and boat launch ramps contributed to the loss of natural environments and biodiversity. The impact of these facilities on the environment varies depending on the type of structure in question, whether wharf, launch ramp or marina, with marinas generally having the biggest impact. A 1991 study identified three types of impacts of marinas: those stemming from the construction of the site, those associated with the effects of the structure and those resulting from the consequences of their operation[125].

The construction or expansion of a new marina frequently necessitates dredging. Although the issue of sediment contamination appears to be a minor consideration in the construction of a marina as compared to a commercial port, the impacts of dredging activities should not be dismissed. Indeed, these activities lead to the destruction of riparian sites that are often rich in plant communities and major spawning habitats for certain species of fish. Sediments can be swept away by the current and settle on adjacent habitats during dredging. The presence of marinas in the environment may lead to varying degrees of changes in hydrodynamics, depending on the scope of the work and in-place structures like breakwaters. These structures may also create new sediment deposition zones that are likely to modify existing habitats. Marina operations can also disturb wildlife species when boating activity is intensive and localized[126]. Moreover, the concentration of a high number of pleasure craft and support services (e.g., restaurants, maintenance) can generate solid and liquid pollutants that can affect the quality of the water and sediments near or within harbor areas, inasmuch as septic tanks are not emptied as per regulations.

V. E. Invasive Species

Recent estimates suggest that there are over 600 aquatic and terrestrial non-native species in the Great Lakes region[127]. When non-native species are introduced into an environment in which they did not evolve, there often is no natural predator available to control their population. With no natural enemies, they have the unique ability to invade and displace native species, spread foreign diseases, and alter ecosystem dynamics.

FACT

Recent estimates suggest that there are over 600 aquatic and terrestrial non-native species present in the Great Lakes region. With no natural enemies to limit their spread, they have the unique ability to invade and displace native species, spread disease and alter ecosystem dynamics.

While only small percentage of these invasives creates serious problems, the problems can be costly and can wreak havoc on natural areas. The Lake St. Clair region has many invasive species found throughout the larger Great Lakes region, including: the zebra mussel, round goby, tubenose goby, Eurasian water milfoil, *Phragmites*, Emerald ash borer and purple loosestrife. Species that are suspected of being on the verge of entering the St. Clair watershed include the spiny waterflea and the European ruffe. While there are limited studies of the impact of these invasive species specific to Lake St. Clair, experts believe that continued introduction of invasive species is one of the greatest threats to the area's biodiversity.

This section provides an overview of the predominant invasive species that are known to be present in Lake St. Clair and its watershed[129]. The presence of invasive species was determined by conducting a literature and database review. In most cases, information regarding the distribution and abundance of the species is generally not known and is an important area for future research and monitoring.

Invasive, Exotic, Noxious Alien or Nonidengenous?

There is no commonly accepted vocabulary for invasion terminology. Davis and Thompson argue that, "inconsistent and imprecise use of invasion terminology is one factor that is contributing to the ongoing difficulties of the field... Until a commonly accepted vocabulary is adopted by invasion ecologists, we think the field will continue to have difficulty developing reliable generalizations, partly due to misunderstandings and misinterpretations among investigators[128]."

V. E. 1. Aquatic and Wetland Invasives

Wetland and Aquatic Invasive Plants

Phragmites

Phragmites australis or common reed is a very aggressive, perennial wetland grass that ranges in height from 3 to 13 feet. It is a native of the Americas and Eurasia but the highly invasive form that is rapidly colonizing U.S. wetlands originated in Europe and is now found in every state of the U.S. This hearty species inhabits salt and freshwater and tolerates pH ranges and other environmental features that most marsh grasses will not. *Phragmites* produces seed but usually spreads via underground rhizomes, which is often linked to human-induced disturbances.

HIGHLIGHT

In recent years, the Lake St. Clair coastal area - has seen dramatic increases in the Phragmites population where it continues to thrive and spread.

Phragmites is a significant concern in the Lake St. Clair region as it negatively impacts both coastal and inland wetlands by out-competing and crowding out most non-woody native wetland plants that may be important foods for native wildlife and fish[131].

In recent years, the Lake St. Clair coastal area - has seen dramatic increases in the *Phragmites* population[132] where it continues to thrive and spread.

FACT

The Galerucella beetle, a natural enemy of purple loosestrife, has been credited with wiping out large stands of this invasive species in southern Michigan.

Purple Loosestrife

Purple Loosestrife is a native European plant species, which has aggressively invaded North American wetlands, lakes and rivers. It is commonly found in wetlands such as cattail marshes, sedge meadows, and open bogs and tolerates a wide range of soil types.[133] It spreads rapidly in areas where soil has been disturbed and can often be found in retention ponds and drainage ditches. Like *Phragmites*, purple loosestrife can out-compete native vegetation and displace native plants thereby reducing biodiversity, altering the hydrology of the wetland and eliminating food and shelter for fish and wildlife[134]. Purple loosestrife is a widespread and serious problem that continues to invade and thrive in wetlands throughout southeast Michigan and southern Ontario, including around Lake St. Clair.

FACT

Phragmites, purple loosestrife and Eurasian water-milfoil each have the tendency to form dense cover that shades out native vegetation, alters species composition and impairs fish spawning.

To date, few viable solutions for managing this invasive weed have emerged. Control by water level management, burning, herbicides, direct digging, cutting) has proven to be extremely difficult and is impractical on a large scale. An alternative is the biological control through the introduction of natural enemies[135]. The non-native *Galerucella* beetle has been credited with wiping out large stands of purple loosestrife in southern Michigan[136].

Eurasian Water-Milfoil

Eurasian water-milfoil is a non-native rooted aquatic plant that can grow in a variety of aquatic habitats, but grows best in alkaline systems with high concentrations of dissolved inorganic carbon. It has long stems that branch near the water's surface to create a cover of floating foliage. It

CASE STUDY

Restoration of Phragmites Dominated Wetlands In Lake St. Clair Marshes[130]

Michigan Department of Natural Resources work in the St. Clair Flats and Algonac State Park has included a multi-year study to assess methods and develop techniques for controlling *Phragmites australis* where it is invading expansive areas of Great Lakes marsh and lakeplain prairie. In 2001, the herbicides glyphosate and imazapyr were tested, alone and in combination, in test plots in St. John's Marsh and Algonac State Park, and prescribed burning during the following winter was also utilized on some plots. Vegetation was assessed prior to treatment and then again in each of the following two years. Both herbicides were effective in reducing *Phragmites* cover, but were most effective when used together. Plots treated with herbicide followed by burning showed a relatively significant 12 percent increase in recovery of native plant species, while herbicide-treated plots which were not burned showed no significant release of native species.

In 2003, surveys were conducted and samples collected for potential fungal biological control agents throughout the study area. Biological control is still in the early stages and it may not be clear if it is an effective control method for several years. Long term research is needed to study the effects of biological control agents not only on the target plant, but also on non-target species. Interestingly, no native Phragmites genotypes were found in the SE Michigan region.

Glyphosate and imazapyr were also applied to remote areas for photo analysis in 2002/2003. Future post-treatment evaluations will provide additional information on the duration of *Phragmites australis* control as well as the diversity and recovery of native wet-prairie plants. Based on the results of the initial tests, the study will provide guidance for developing a targeted and long term lakeplain prairie restoration plan for zones in the St. Clair Flats Wildlife Area that are being impacted by *Phragmites*.

FACT

The increased water clarity due to zebra mussel filtering has decreased the amount of low light habitat preferred by walleye.

is an opportunistic species that invades disturbed lake beds, recreational waterways and slow moving streams and can rapidly colonize through plant fragmentation as each fragment is able to grow roots and develop into a new plant. Native to Europe, Asia and northern Africa, this invader has been spread intentionally by fishermen who introduced it to lakes for fish habitat and accidentally by recreational boaters who inadvertently carried it to other waters. Once established, it forms dense cover that shades out native vegetation, alters species composition of aquatic invertebrates, and impairs fish spawning. Like *Phragmites* and purple loosestrife it also negatively impacts water recreation activities such as swimming, boating and fishing due to its dense growth.

Wetland and Aquatic Invasive Animals

Zebra Mussel

The zebra mussel, native to the Caspian Sea region, was first discovered in Lake St. Clair in 1988. Since then, it has spread to all five Great Lakes. Because zebra mussels attach themselves in barnacle-like colonies to water intake screens and restrict water flow, they have caused extensive problems for industries and municipalities that rely on large-scale water withdrawals. The ecology of native mussel communities changed substantially after the invasion of the zebra mussel. Unable to adequately compete with the zebra mussel, virtually all of the 18 native species have been extirpated from the open lake. Zebra mussels effectively filter water at relatively high rates and have consequently increased water transparency, particularly on the Ontario side of the lake.

Increased water clarity has changed the previously turbid system into a clear water system dominated by macrophytes, which has increased spawning and feeding habitat for many sport fishes, including muskellunge, smallmouth bass and yellow perch, while it decreased the low light habitat preferred by walleye. An additional concern with zebra mussels is that they may bioaccumulate contaminants that could then be passed to predators, many of which are popular sport and commercial fish species.

Sea Lamprey

Sea Lamprey are a primitive, jawless fish native to the Atlantic Ocean. They have a large mouth with sharp teeth designed for sucking and a well developed sense of smell, which they use to attach themselves to fish and such out their body fluids. This often kills the prey, and is one of the reasons why the lampreys have had an enormous negative impact on Great Lakes fishery[137]. Sea lamprey first appeared in Lake Ontario in the 1830's and eventually spread throughout

all of the Great Lakes. Sea Lamprey were a major cause of the collapse of lake trout, white fish and chub populations in the Great Lakes during the 1940s and the 1950s[138]. The Great Lakes Fishery Commission manages a sea-lamprey control program.

Round and Tubenose Gobies

Round and tubenose gobies are bottom-dwelling fish that were discovered in the St. Clair River in 1990. Round goby are aggressive, voracious feeders that can forage in total darkness. The round goby takes over prime spawning sites traditionally used by native species, competing with native fish for habitat and changing the balance of the ecosystem[139].

FACT
Round gobies, an aggressive species, have taken over the spawning sites of several native fish species.

Gobies can also survive in degraded water conditions, and spawn more often and over a longer period than native fish. They are found in high abundance in the St. Clair River and Lake St. Clair and are also common along the tributaries to the lake and river. In Lake St. Clair, round gobies have become an important component of the diet of muskellunge, smallmouth bass and yellow perch.

V. E. 2. Terrestrial Invasives

Terrestrial Invasive Plants

Honeysuckle

A variety of introduced honeysuckle shrub species originating in Asia and Russia that have invaded native woodlands with disastrous results. Typically, they are dispersed by birds which eat their abundant berries and are most common in disturbed forest, edge and forest openings, although they can invade healthy forest interiors as well. They leaf out before native species and shade out tree seedlings and herbaceous groundcover, inhibiting forest regeneration[140].

HIGHLIGHT
Buckthorn and honeysuckle are invasive shrubs or small trees that are dispersed by the birds that eat their berries. They invade old fields, forest edge and interior, shading out the native flora.

Buckthorn

Both common buckthorn and glossy buckthorn are shrubs or small trees and were probably introduced to North America prior to 1800, but did not become naturalized until the early 1900s. Both are native to Europe and Asia, and glossy buckthorn is native to North Africa as well. Their seeds are dispersed by a variety of birds and mammals, and rapidly invade apparently stable habitat. Buckthorns have long growing seasons, rapid growth rate, and resprout vigorously following top removal. Like honeysuckle, they shade out native tree seedlings and inhibit the growth of herbaceous understory species[141].

Privet

There are about 50 species of privet that are native to Europe , Asia and North Africa, and many have been developed as hedge plants. The genus includes deciduous, semi-evergreen and evergreen forms. They can easily escape cultivation and invade adjacent areas to form dense, monospecific thickets. Common privet is widely established in the U.S. and southern Canada. Privet invades both disturbed settings, such as roadsides and old fields as well as a wide variety of undisturbed habitats: bogs, wetlands, floodplains, barrens and hardwood forest. Its dense thickets outcompete many sorts of native vegetation[142].

Autumn Olive

Autumn olive is a shrub or small tree that is native to China, Korea and Japan and was introduced to the United States for cultivation in 1830. In many areas it was widely recommended for use in habitat plantings but it invades disturbed areas adjacent to the plantings where encroachment can be rapid due to the high production of seeds, high germination rate, and hardiness of the plants. It is one of the earliest species to leaf out in spring, shading out many native plants. Autumn olive thrives in a number of settings and is capable of fixing nitrogen. Because of this, it poses a particular threat to native species that are dependant on infertile soils[143].

Garlic Mustard

Garlic mustard is an herbaceous biennial that invades forested communities and edge habitats. The plant has no known natural enemies in North America, is self-fertile, and is difficult to eradicate once established. It is one of the few herbaceous species that invade and dominate the forest understory. In its first season it develops a distinctive basal rosette and in its second year sends up one or more flowering stalks. A single plant averages 136 – 297 seeds but can produce over 7,000 seeds, effectively dominating the seedbank. Garlic mustard dominated woodlands are characterized by low native herbaceous diversity[144].

FACT
Garlic mustard is one of the few herbaceous species that invade and dominate the forest understory.

Sweetclover

Yellow and white sweetclover are herbaceous legumes that are native to the Mediterranean area and have been used extensively as forage crops, soil builders and as a nectar source for honey bees. They have escaped from cultivation and are widely distributed along roadsides and old fields throughout the U.S. and Canada. They are a threat to recovering prairies because they easily invade open areas and may compete for resources with native species or indirectly affect the prairie community by altering soil conditions[145].

Spotted Knapweed

Spotted knapweed is native to Europe and was most likely introduced to the eastern U.S. in the 1890s in alfalfa seed from Asia Minor, although it was then transported to the Pacific Northwest in soil carried as ballast. It appears to thrive in disturbed areas but then successfully invades adjacent undisturbed lands. Although the primary emphasis on controlling spotted knapweed has focused on its presence in pasture and rangelands, it poses a serious threat to restored grasslands as well[146].

FACT
Smooth brome can be particularly difficult to eradicate in fallow fields that are otherwise ideally suited for grassland restoration.

Smooth Brome

Smooth brome is a Eurasian grass species that was apparently introduced in the United States in 1884 for use as forage. It is a cool season exotic that is especially troublesome in disturbed portions of old pastures in the tallgrass and mixed prairie regions. It forms a dense sod that often appears to exclude other species, thus contributing to the reduction of species diversity in natural areas. Smooth brome has become established in overgrazed pastures and old fields but also appears to be invading native prairie from roadsides[147].

Terrestrial Invasive Animals

Emerald Ash Borer

The Emerald Ash Borer is a beetle indigenous to Asia. It was first identified in southeast Michigan in July of 2002 and was also identified in the Windsor, Ontario area that same year. It attacks and kills ash trees that are larger than 1 inch in diameter. It has no known natural enemies and native trees do not appear to have any resistance to the beetle. This beetle is a significant threat to all ash species in the Detroit and Windsor areas[148]. It has also been identified in Ohio, Indiana, Maryland[149] and Virginia[150].

HIGHLIGHT
The Emerald Ash Borer was first identified in the southeastern Michigan in July of 2002 and was identified in Windsor, Ontario later that year.

Michigan has an emerald ash borer task force, which consists of the USDA's Animal and Plant Health Inspection Service, the U.S. Forest Service, the Michigan Department of Agriculture, the Michigan Department of Natural Resources and Michigan State University. In early 2004, state officials asked local governments to declare a local state of emergency by March 15 because of damages caused by the borer. An emerald ash borer policy director has been appointed to coordinate emerald ash borer initiatives among the governor's office, the Michigan Department of Agriculture, DNR, the state police and the Michigan Department of Transportation. In March 2004, the U.S. Department of Agriculture announced that it will provide $28.2 million to help beetle control efforts.

Asian Long-horned Beetle

Asian long-horned beetles are about 1 to 1 1/2 inches in length, are black and shiny with white spots and have long distinguishable antennae that are banded with black and white. They attack many different hardwood trees, including maple, birch, horse chestnut, poplar, willow, elm, ash and black locust.

The beetle was first reported in the New York area in 1996, where it is thought to have entered via wood packing material from China. The beetle is a serious threat to hardwood trees and has no known natural predator in the United States. If the Asian long-horned beetle becomes established, it has the potential to cause more damage than Dutch elm disease, chestnut blight, and gypsy moths combined, destroying millions of acres of hardwoods. The beetle has the potential to damage such industries as lumber, maple syrup, nursery, commercial fruit, and tourism[151]. The beetle was discovered in wood packing material from China in two warehouses in Michigan – one of which falls within the Lake St. Clair watershed (Warren, Michigan)[152].

V. E. 3. Potential Invasives of the Lake St. Clair Region

Potential Invasive Animals

FACT
On the verge of invading Lake St. Clair, the Ruffe is considered a serious threat to the yellow perch commercial and sport fishing industry.

Ruffe

The Eurasian ruffe is a member of the perch family. It was first reported in western Lake Superior in 1986 from ballast water of ocean-going vessels[153]. As of spring 2002, ruffe have spread along Lake Superior to Lake Huron[154]. The ruffe has not yet been found in Lake St. Clair, but is considered to be on the verge of invading.

The Eurasian ruffe poses a serious ecological threat to the aquatic ecosystem and to sport and commercial fishing. Maturing quickly, the ruffe has a high reproductive capacity and adapts to a wide variety of environments. Explosive growth of the ruffe population reduces food and space for other fish with similar diets and feeding habits. It is consid-

ered a serious threat to the yellow perch commercial and sport fishing industry. It also has the potential to seriously disrupt the delicate predator/prey balance vital to sustaining a healthy fishery.

Spiny Water Flea

The spiny water flea is a tiny crustacean with long, sharp, barbed tail spines. The spiny water flea, a macroscopic invertebrate, was observed in high abundances in the St. Clair River by the late 1990s and has become an integral part of the zooplankton community; however its effect on native species remains essentially unknown[155]. The fishhook water flea has not yet been collected in Lake St. Clair but is considered to be on the verge of invasion.[156]

Water fleas prey on zooplankton and may be competing for food with native species. Larger fish find them unpalatable because of their spiny and fishhook tails. For these reasons, they have the potential to alter aquatic food webs of the Great Lakes. If so, this may result in further restriction on human consumption of fish, which would impact both commercial and recreational fisheries.

Asian Carp

Bighead, silver, grass and black carp all are native to Asia. Grass carp were first introduced into the United States in 1963; bighead, silver and black carp appeared in the 1970s. All four species of Asian carp escaped into the Mississippi River Basin, and all but the black carp are known to have developed self-sustaining populations there[157].

Asian carp are large, prolific, voracious feeders and have the potential to disrupt the food chain that supports native fish in the Great Lakes. They can reach over four feet in length and 100 pounds, and the climate in Asia where they originated is similar to that of the Great Lakes. If they reach the Great Lakes, they could eventually become a dominant species[158].

HIGHLIGHT

Asian carp are large, prolific, voracious feeders and have the potential to disrupt the food chain that supports native fish in the Great Lakes.

Asian carp have been found in the Illinois River, but federal and state agencies are working to prevent their movement into Lake Michigan. The U.S. Army Corps of Engineers constructed a temporary electrical fish barrier on the Chicago Sanitary and Ship Canal in April, 2002. The Illinois Natural History Survey has been monitoring the effectiveness of the temporary barrier, which is informing the design of a second, more permanent barrier, scheduled to be completed in February of 2005[159].

Northern Snakehead

The northern snakehead (*Channa argus*), a native of China, was first found in the U.S. in 1977 An established population was discovered in a pond in Maryland in 2002, which was eradicated, but in 2004, they were discovered in the Potomac River[162]. Also in 2004, a fisherman caught an adult snakehead, believed to be a released pet, in Chicago's Burnham Harbor[161].

Snakeheads have the potential to wreak havoc among native populations of fish in the Great Lakes. As juveniles, they eat microscopic zooplankton and crustaceans, and then transition to fish, insects, crustaceans as adults. Snakeheads can survive in water with very low oxygen – all are capable of obtaining oxygen from air, and some species can use either air or water for respiration. Where they have been introduced, they impact native species both by competition for food, and also by direct predation on native fish populations.

In the U.S. all species of snakeheads have recently been assigned injurious wildlife status under the Federal Lacey Act which prohibits the importation and interstate transportation of wildlife deemed by the Secretary of the Interior to be "injurious" to humans, agriculture, or other wildlife resources. This includes both live snakeheads as well as viable eggs[162].

Potential Invasive Plants

Hydrilla

Hydrilla verticillata is thought to have been introduced to the U.S. in the 1950's from the Indian subcontinent, and has been categorized as one of the world's worst weeds. Infestations of *Hydrilla* are extremely severe and can completely choke entire lakes and public water supplies[163]. *Hydrilla* is particularly threatening because of its diverse reproductive abilities (it can reproduce by seed, vegetative cuttings and tubers) and its ability to grow in dark, deep waters where other plants cannot survive, eventually forming thick mats on the surface and preventing the sunlight from penetrating to native plants such as wild celery and coontail below[164, 165].

FACT
Hydrilla can reproduce by seed, vegetative cuttings and tubers.

Researchers have noted reductions in size and weight of sportfish where *Hydrilla* dominates the water column, suggesting that it effectively reduces foraging efficiency[166]. *Hydrilla* seriously affects water flow and its heavy growth can obstruct boating, swimming and fishing. *Hydrilla* is now found in states bordering the Atlantic and Pacific, and approaches the Great Lakes most closely in Pennsylvania and New York[167, 168]. To date, *Hydrilla* has not been found in the Great Lakes.

V. E. 4. Key Programs

United States Federal Programs

Congress has supported aquatic nuisance species prevention and control through the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 (NANPCA) and its reathorization through the National Invasive Species Act of 1996 (NISA). While progress has been made, a number of persistent and complex problems face ANS prevention and control. To this end, the proposed National Aquatic Invasive Species Act (NAISA) will reauthorize and strengthen regulations required under NISA. Additionally, NAISA will require all vessels equipped with ballast operating in waters of the United States to have an aquatic invasive species management plan that prescribes ways to minimize introductions and transfers of invasive species.

FACT
Invasive species can be introduced through a wide variety of pathways, including ballast water, aquaculture, aquarium trade, biological control, recreational boating, recreational fisheries enhancement, bait businesses and horticultural practices, among others.

The **Great Lakes Panel on Aquatic Nuisance Species** (the Panel) has been working since 1991 to prevent and control the occurrence of invasive aquatic nuisance species in the Great Lakes. Convened by the Great Lakes Commission in response to NANPCA, the panel is comprised of representatives of U.S. and Canadian federal agencies, the eight Great Lakes states and the Province of Ontario, regional agencies, user groups, local communities, tribal authorities, commercial interests and the university/research community. The Panel is charged with identifying Great Lakes priorities, making recommendations to a national Task Force on Aquatic Nuisance Species, coordinating invasive species programs and activities in the region, and advising public and private interests on control efforts.

The Great Lakes Panel on Aquatic Nuisance Species is currently working on a Rapid Response Plan for Great Lakes Aquatic Invasions and details can be found at the following website: *www.glc.org/ans/pdf/ModelRRPlan-II_04-04.pdf.*

Ballast water has been identified as a major pathway for introduction and dispersal of aquatic invasive species. Several federal agencies have regulatory authority and management programs for ballast water control. The U.S. Department of Transportation recently announced regulations for the St. Lawrence Seaway that require vessels to adopt and comply with best management practices for ballasting operations in order to minimize introduction and dispersal of aquatic invasive species. These management practices must be met before a commercial vessel can be cleared for transit in the Seaway system. U.S. Coast Guard regulations require that partially laden ships destined for the Great Lakes from abroad discharge and exchange their ballast water in mid-ocean with the intent to flush out potential invaders. However, this ballast water exchange program is only a first step to reduce future invasions. The U.S. Environmental Protection Agency has prepared a Draft Ballast Water Report (2001) that summarizes the results of a study on aquatic invasive species in ballast water discharges, which, when finalized, will include a number of regulatory and non-regulatory recommendations.

FACT

Ballast water has been identified as a major pathway for introduction and dispersal of aquatic invasive species.

A number of U.S. federal agencies have regulation, research, and management responsibilities for invasive plant species. The U.S. Department of Agriculture's Animal and Plant Health Inspection Service (APHIS) works to prevent the introduction of nonnative plants, as well as their establishment on private lands. APHIS works with state and local agencies as well as private landowners and managers to eliminate invasive plants on private lands, as well as regulating importation of biological control agents. The U.S. Department of Agriculture's Agricultural Research Service conducts basic research on agricultural weeds. Weed research and management on federal lands is conducted by a number of land management and scientific agencies, including the U.S. Forest Service, U.S. Fish and Wildlife Service, National Park Service, Bureau of Land Management, Bureau of Reclamation, U.S. Geological Survey, and Bureau of Indian Affairs. The departments of Defense, Energy, and Transportation are also involved in weed management.

GAP

There is a paucity of programs dedicated to detecting new invasions and monitoring existing populations of invasives[169].

In response to the economic and biological threat posed by invasive plants, 16 federal agencies have formed the Federal Interagency Committee for the Management of Noxious and Exotic Weeds (FICMNEW). The committee's goal is to facilitate the development of biologically sound techniques to manage invasive plants on federal and private lands. The committee promotes the invasive plants programs of individual agencies as well as interagency projects that emphasize invasive plant prevention, timely control, and restoration of degraded lands. The national program also includes research, monitoring, and public awareness elements. Another primary goal of the interagency committee is to form partnerships with state and local agencies and non-governmental organizations to identify new ways to deal with invasive plants. These partnerships help facilitate the exchange of expertise and resources and ensure a voice for private industry, landowners, and others who are directly affected by invasive plants.

Canadian Federal Programs

Canada has long-established laws and regulations to prohibit or restrict the entry of foreign animals or plants capable of causing economic damage to agricultural crops, livestock or forest trees. The introduction of quarantine pests is regulated through the Canadian Food Inspection Agency (CFIA). The Agency also performs surveillance domestically to identify, control, or eradicate regulated pests that have entered Canada. However, there is no similar program to protect ecosystems and habitats from invasive species. A 2002 audit by the Office of the Auditor General of Canada criticized

GAP

Binational coordination is needed to address transboundary and ecosystem threats from invasive species.

the federal government for not developing an effective response to protect Canada's ecosystems, habitats, and native species from invasive species.

In response, Environment Canada is coordinating the development of a national plan to address the threat of invasive alien species in partnership with the Canadian Food Inspection Agency, Fisheries and Oceans Canada, Transport Canada. The plan will outline processes for the identification and assessment of invasive species and pathways of invasion, priorities for action, and measures to be taken to address these priorities. Fisheries and Oceans Canada will take the lead role with respect to the portion of the national action plan that deals with aquatic invasive species. Fisheries and Oceans will work collaboratively with other federal departments, provincial governments and stakeholders to develop a plan to address aquatic species issues in Canada.

With respect to ballast water control, Transport Canada has primary authority and is responsible for the management of ballast water on board ships entering Canadian waters. Guidelines regarding ballast water in the Great Lakes and St. Lawrence Seaway were developed in 1989 and extended to all Canadian waters in 2000. Under Transport Canada guidelines, all ships entering Canadian waters must verify compliance and samples may be taken from their ballast water. Currently, this is a voluntary program for the purpose of reducing the risk of introducing harmful aquatic non-indigenous organisms and pathogens. Flushing and refilling a ship's ballast tanks with mid-ocean saltwater while still at sea is currently the most accepted method of control but it is not always effective.

GAP

Currently, no formal "Rapid Response" protocol exists in the U.S. or Canada to allow for the immediate implementation of appropriate eradication or control measures when a new invasive species is discovered.

Transport Canada and the U.S. Coast Guard share information on compliance with U.S. ballast water regulations under the Great Lakes Water Quality Agreement. Since 1993 the U.S. Coast Guard has inspected all ships entering the Great Lakes, enforcing U.S. laws. It provides the compliance data for the binational report to the International Joint Commission, which is prepared by Transport Canada, the Canadian Coast Guard, and the U.S. Coast Guard. While Transport Canada is responsible for regulating ballast water and preventing the introduction of aquatic invasive species by ships, it relies exclusively on U.S. inspection and enforcement in the region. The Office of the Auditor General of Canada has recommended that Transport Canada and U.S. authorities formalize arrangements for sharing current information on compliance with U.S. ballast water regulations and for coordinating efforts to regulate, monitor, and enforce ballast water regulations.

Michigan Programs

In August 2001, the Michigan Legislature passed Public Act 114 of 2001 to address the on-going invasion of aquatic invasive species. The law, which was supported by the maritime industry, requires the MDEQ to determine:

- Whether vessels operating on the Great Lakes and the St. Lawrence Seaway are complying with ballast management techniques,
- Whether ballast water management practices have been made a condition of passage on the St. Lawrence Seaway, and then
- Compile and maintain lists of vessels that comply with these management practices or treatment methods.

The Michigan Aquatic Nuisance Species Council, created by the Michigan Governor in 2002, advises the Office of the Great Lakes and the Departments of Environmental Quality, Natural Resources, Agriculture and Transportation on the implementation of Michigan's Aquatic Nuisance Species Management Plan Update as well as on the state's efforts to prevent and control invasive species introductions and spread within Michigan.

Many state and local agencies have invasive plant management responsibilities. The Michigan Department of Environmental Quality regulates the entry of invasive plants into the state by prohibiting the sale and movement of plants and by regulating high risk vectors. Its Angler's Monitoring Network was created for the purpose of reporting new sightings of invasive fish, and its website is: www.michigan.gov/deq-anglers-monitoring-network. The Michigan Department of Agriculture, Michigan Department of Natural Resources, and Michigan Department of Transportation also have invasive plant management responsibilities. Michigan also has a Michigan Invasive Plant Council that is comprised of representatives from federal, state, and local agencies, universities, and private organizations and individuals. The Council, formed in 2000, promotes the exchange of information and encourages the development of responsible solutions to control invasive plants.

Efforts at all levels of government are underway to prevent and control the spread of invasive species. Given interstate commerce protections, international trade agreements, and the geographic scope of the Great Lakes, many believe that action at the federal level in the United States and Canada may be the best approach for preventing the introduction of new invasives via the shipping industry.

Table V. E. 1
Key Invasive Species in Lake St. Clair Coastal Region

Aquatic & Wetlands Plants			
Name	**Origin**	**Introduction Date**	**Impact**
Common reed *Phragmites australis*	Circumpolar	Rapid expansion of non-native genotypes since early to mid-1990s[181]	Invades healthy and degraded wetlands, forming dense monocultures. In coastal areas, can alter natural systems by increasing the elevation of marsh surfaces and reducing the frequency of tidal inundation[171, 172].
Eurasian water-milfoil *Myriophyllum spicatum*	Europe, Asia and north Africa	Washington, D.C., in 1942	Dense growth habit shades out native vegetation, alters species composition of aquatic invertebrates, and impairs fish spawning. Impairs use of area for swimming, boating and fishing due to its dense growth[173].
European Frogbit *Hydrocharis morus-ranae*	Europe	First identified in Michigan in 2000	Forms dense floating mats that can reduce growth of native submersed aquatic plants[174].
Flowering rush *Butomus umbellatus*	Eurasia	1918 in Michigan	considered a moderate threat, but capable of aggressively displacing native vegetation
Hydrilla *Hydrilla verticillata*	Indian subcontinent	1950s	Hydrilla can reproduce by seed, vegetative fragments and tubers, forming dense mats, choking entire lakes and public water supplies.
Purple loosestrife *Lythrum salicaria*	European	1800s	Out-competes native vegetation, reduces biodiversity and degrades habitat quality. Impedes water flow in drainage[175].
Reed canary grass *Phalaris arundinacea*	circumpolar distribution	non-native strain introduced in 1880s	Reed canary grass reproduces vegetatively and by seed, quickly forming a monoculture and replacing the native vegetation

Aquatic & Wetlands Animals			
Name	**Origin**	**Introduction Date**	**Impact**
Alewife *Alosa pseudoharengus*	Atlantic Ocean	late 1800's.	In Lake St. Clair, alewives seasonally dominate the forage fish population. Have altered species make-up within the Great Lakes, frequently out-competing lake herring, whitefish, chubs and perch for plankton and other prey.
Asian Carp *Hypophthalmichthys spp. & Ctenopharyngodon idella*	Asia	1960s	Large, prolific feeders that have the potential to out-compete native fishes, disrupting food chain.
Carp *Cyprinus Carpio*	Europe	Eastern Lake Erie in 1883	Can destroy vegetation and increase water turbidity by dislodging plants and rooting around in the substrate, causing a deterioration of habitat for species requiring vegetation and clean water[176].
Eurasian ruffe *Gymnocephalus cernuus*	Eurasia	On the verge of invasion to Lake St. Clair	The ruffe, with its high reproductive rate, may pose a serious threat to existing fish community, and sport and yellow perch commercial fishery, by out-competing fish for food and space.
Northern snakehead *Channa argus*	China	1970s	Prey on native fish for food and compete with them as well. Can tolerate low oxygen conditions
Rainbow smelt *Osmerus mordax*	Eastern coast of North America	Early 1900's	Eat a wide range of prey, making this species a threat to native fishes. Can negatively impact native species through recruitment reductions, population declines, and potentially the extirpation of native species[177].
Round goby *Neogobius melanostomus* **Tubenose goby** *Proterorhinus marmoratus*	Europe - Black and Caspian Sea region	St. Clair River in 1990.	Aggressive, voracious feeders which can forage in total darkness and take over prime spawning sites used by native fish species.
Sea lamprey *Petromyzon marinus*	Atlantic Ocean	Lake Ontario in the 1830's	Attach to fish with their sucking mouth and sharp teeth, and suck out their prey's body fluids, often killing them. Enormous negative impact on Great Lakes fishery[178].
Spiny Water Flea *Bythotrephes cederstroemi*	Great Britain and northern Europe	On the verge of invasion to Lake St. Clair	Effect on native species remains essentially unknown. May be competing for food with native species. Larger fish find them unpalatable because of their spiny tails, so they have the potential to alter the food chains of the Great Lakes.
Zebra mussel *Dreissena polymorpha*	Caspian Sea region of Asia	Lake St. Clair in 1988	Have decimated native mussel populations. Zebra mussel filtering has increased water clarity and macrophyte growth in Lake St. Clair, - increasing habitat for some species and decreasing it for others.

Terrestrial Invasive Plants			
Name	**Origin**	**Introduction Date**	**Impact**
Autumn olive *Eleagnus umbellata*	Asia	1830	Invade old fields, forest edge. As they leaf out early, they shade out native groundcover, decreasing diversity. They produce prolific seeds, have a high germination rate and can fix nitrogen. Dispersed by birds.
Buckthorn *Rhamnus spp.*	Europe and Asia	1800s	Invade old fields, forest edge and interior. They leaf out early, shading out spring ephemerals, grow rapidly and resprout vigorously following top removal. Seeds dispersed by birds and mammals.
Cheatgrass *Bromus tectorum*	Mediterranean region	Late 1800s	Aggressive invader that can completely out-compete native grasses and shrubs and negatively impacts agricultural systems[179].
Garlic mustard *Alliaria petiolata*	Europe	1868	Garlic mustard invades forested communities and edge habitats, reducing species diversity. It has no known natural enemies in North America, is self-fertile, and is difficult to eradicate once established.

Honeysuckle *Lonicera spp.*	Asia and Russia	1800s	A number of bush honeysuckle apecies invade old fields, forest edge and interior. As they leaf out early, they shade out native groundcover, decreasing diversity. Dispersed by birds.
Japanese honeysuckle *Lonicera japonica*	Eastern Asia	Late 1800's	Blocks sunlight from getting to other plants and eventually smothers them. Can stunt the growth of native shrubs or small trees by strangling them and preventing water from moving through the plant[180].
Japanese knotweed *Polygonum cuspidatum*	Japan	Late 1800's	Forms dense thickets that can shade out other plants. Can colonize extensively in riparian areas and once established, it is difficult to remove[181].
Leafy spurge *Euphorbia esula*	Eurasia	Early 1800s	In high densities, it can reduce the cover of grasses and forbs[182] (8). Studies have shown that native plant species may be severely affected by leafy spurge[183] (9), which may also have a negative impact on wildlife populations[184] (10, 11).
Multiflora rose *Rosa multiflora*	Eastern Asia	Late 1800's	Can form extremely dense thickets that crowd out other vegetation and hinder the growth of native plants. Dense thickets can inhibit forest regeneration, and can become a dominant part of a forest understory.
Privet *Ligustrum spp.*	Eurasia and North Africa		Escapes cultivation to form dense, monospecific thickets. Can invade both disturbed areas as well as a variety of undisturbed habitats.
Smooth brome *Bromus inermis*	Eurasia	1884	Cool season grass which forms a dense sod, excluding other species and reducing diversity in natural areas.
Spotted knapweed *Centaurea maculosa*	Europe	Late 1800's	Rapidly colonizes disturbed areas, and infests adjacent habitats that are relatively undisturbed or in good condition. Crowds out native vegetation.
Sweetclover *Melilotus spp.*	Mediterranean region	1664	Herbaceous legumes that compete aggressively with natives and can indirectly affect prairie communities by altering soil conditions.
Tree-of-heaven *Ailanthus altissima*	China	Late 1800's	Rapidly colonizes due to seeds that are easily transported and high seed germination. Is fairly tolerant of shade and can spread quickly in disturbed forest areas. The roots produce a toxin that acts as a herbicide that can kill or inhibit other plant growth.

Terrestrial Invasive Animals			
Name	**Origin**	**Introduction Date**	**Impact**
Asian long-horned beetle *Anoplophora glabripennis*	China	First reported in the New York area in 1996	Is a serious threat to hardwood trees, attacking maple, birch, horse chestnut, poplar, willow, elm, ash, and black locust.
Emerald ash borer *Agrilus planipennis*	Asia	Identified in southeastern Michigan and Windsor in 2002	Attacks and kills ash trees that are larger than 1 inch in diameter. It has no known natural enemies and native trees do not appear to have any resistance to the beetle.
Mute Swan *Cygnus olor*	Eurasia	Lower Great lakes in the Mid-1960s and 1970s.	High concentrations of Mute Swans can overgraze an area, causing a functional reduction in aquatic habitat[185]

V. F. Natural Disturbances/Stressors

Natural disturbances are differ from those discussed previously in that they are primarily due to natural phenomena with a minimal level of human influence. Examples of natural habitat stressors are ice storms, wildfire, windthrow, flooding and Great Lakes water level fluctuations. However, in today's world, most, if not all, natural disturbances are at least indirectly influenced by humans. For example, global warming, which has been attributed to an increase in greenhouse gases produced by humans, has been linked to changes in the frequency and intensity of storms, melting of glaciers and changes in heating and cooling days, as well as changes in rates of precipitation and evaporation.

Natural disturbances are an integral part of healthy ecosystem dynamics. Although they may change the composition and structure of a natural community, healthy communities are able to rebound over. Some plants have developed adaptations to disturbances and actually require disturbance to proliferate. Storm events that uproot and destroy established wetland complexes can also stimulate new growth, healthy changes in community composition and habitat expansion. Extremely low water levels due to drought can eliminate wetlands but can also expose previously submerged lands that become terrestrial habitat. In both cases, when natural shorelines are present, new plants and animals are able to move in and exploit the new conditions provided by the disturbance. On the land, natural disturbances often provide new habitat, expose the seed bank, release nutrients and open up the canopy to saplings and groundcover. In short they provide opportunities for existing species to persist, other species to exploit and all species to continue along their natural evolutionary path.

HIGHLIGHT

It is important to realize that natural disturbances are an integral part of the natural world.

V. F. 1. Ice Storms

Glaze or ice storms are a significant source of disturbance in hardwood forests of North America[186, 187, 188]. Estimated return interval for severe glaze storms ranges between 20 and 100 years[189]. Glaze results in pruning of small branches, severe breakage of large branches, complete stem breakage and the creation of canopy gaps[190, 191]. Canopy trees affected but not killed by glaze are often subsequently infected by fungus and/or infested by insects and die standing or are eventually windthrown[192]. Sugar maple and beech have been reported to be moderately affected by glaze storms[193] with beech showing greater susceptibility[194]. There has been speculation that beech's tendency to root sprout following stem breakage may compensate for its greater vulnerability to ice damage[195].

FACT

Fire played a key role in maintaining the open structure of grass dominated systems or grasslands and in maintaining a shifting mosaic of natural communities across the landscape.

V. F. 2.Wildfire

Historically, fire was either initiated by lightning or by Native Americans. Fire played a key role in maintaining the open structure of grass dominated systems or grasslands and in maintaining a shifting mosaic of natural communities across the landscape. Fire-dependent systems in the study area include lakeplain oak openings and prairie. Fire also occasionally spread into adjacent systems such as wetlands and mesic forests.

Fire can serve many functions within a natural community. Fire also plays a critical role in preventing declines in species richness in many community types by creating micro-niches for small species[196]. Fire kills or stunts woody plants, converts dead plant material into nutrients, promotes seed contact with soil, warms the soil in early spring which promotes seed germination, opens resinous pine cones and stimulates herbaceous plant growth.

FACT

Flooding in the spring can lead to vernal pools in forests which provide critical breeding habitat for many amphibians.

V. F. 3. Flooding

In Michigan, flooding typically occurs in the spring and fall during long periods of precipitation and shortly after snowmelt. Some areas are more prone to seasonal flooding than others. This is usually the result of a high or perched water table, low elevations and/or close proximity to a large body of water or river system.

CASE STUDY
Michigan Prescribed Fire Council

The Michigan Prescribed Fire Council (*www.firecouncil.org*) is a coalition of individuals, private sector and governmental agencies interested in utilizing or promoting the safe use of prescribed fire as a natural resource management tool. Their mission is to protect, conserve and expand the safe use of prescribed fire on the southern Michigan landscape. They accomplish this mission by:

- Providing a framework for communications related to prescribed fire objectives, techniques and issues;
- Reviewing prescribed fire problems and suggesting courses of action;
- Promoting the safe and responsible use of prescribed fire;
- Disseminating technical information;
- Promoting the development and utilization of prescribed practices to achieve desired environmental resource management goals and
- Promoting public understanding of the benefits of prescribed fire.

The Council offers an annual two-day workshop and a list of consultants who have indicated that they provide prescribed fire service on a fee basis.

Flood waters move sediment and other debris downstream, cause bank erosion and change vegetation composition within the floodplain. Prolonged flooding can kill woody plants and turn a healthy stand of trees into standing snags providing shelter for cavity nesting birds, great blue heron rookeries, and climbing mammals such as raccoon, opossum and porcupine. Standing snags also provide foraging habitat for insectivores such as woodpeckers.

Flooding in the spring can lead to vernal pools in forests which provide critical breeding habitat for many amphibians[197]. A rich food supply of microscopic algae and tiny invertebrates plus a lack of predators contribute significantly to the survival of the egg and tadpole stages of their life cycle. Spotted salamanders, blue spotted salamander, eastern tiger salamander, red-backed salamander, four-toed salamander, eastern American toad, western chorus frog, northern spring peeper, gray treefrog and wood frog are among the amphibians that utilize vernal pools.

Flooding also provides temporary pools for waterfowl as well as fish such as northern pike that use backwater flooded areas adjacent to river systems for spawning. In addition to seasonal flooding, beaver-induced flooding may also play an important role in maintaining open communities by occasionally raising water levels and killing encroaching trees and shrubs that are not adapted to wet, low oxygen conditions. Some, such as willow and ash, are stimulated when flooded to produce new, air-filled roots to replace those that the flood has destroyed. Standing water in the spring and fall prevents shade tolerant woody plants, such as sugar maple, from establishing in the understory.

V. F. 4. Windthrow

The natural disturbance regime in mesic southern forest is characterized by frequent small-scale wind disturbance or gap phase dynamics. The Great Lakes region is one of the most active weather zones in the northern hemisphere with polar jet streams positioned overhead much of the year. More cyclones pass over this area than any other area in the continental U.S.[198]. Severe low-pressure storm systems frequently generate windthrow gaps, or openings in the canopy created by the death of a large branch or one or more trees[199, 200]. Frequent windthrow events generate a forest mosaic of different age classes and species. These small-scale disturbance events are the primary source of forest turnover. The creation of canopy gaps results in temporary increases in the availability of light, water and nutrients and decreases in root competition, which allow canopy recruitment of saplings[201, 202]. Approximately 1% of the total area of mesic forest in the project area is within recent gap (less than one year old) and the average canopy residence time ranges between 50 and 200 years[203, 204].

HIGHLIGHT
The creation of canopy gaps results in temporary increases in the availability of light, water and nutrients and decreases in root competition, which allow canopy recruitment of saplings.

Tree species respond differently to variation in gap size, origin, orientation and age[205, 206, 207]. For example, sugar maple and beech thrive in the common small canopy gaps (20-100m2), while white ash and tulip tree require larger canopy gaps (greater than 400 m^2), which occur less frequently[208, 209]. As gap size increases, woody species diversity and the size and number of stems increase[210]. Gaps formed by wind-uprooted trees are typically larger with more exposed bare soil than gaps formed by stem breakage. Stem-breakage gaps may favor root sprouted saplings (i.e., beech and basswood) and existing advanced regeneration, while uprooted tree gaps can allow recruitment of midtolerant opportunists as well as the shade-tolerant dominants[211].

Spatial and temporal heterogeneity of treefall gaps allows for the maintenance of shade-tolerant canopy dominance and the persistence of mid-tolerant opportunists at low densities[212, 213, 214, 215]. Experts speculate that the relative abundance of beech will increase with low rates of treefall, while sugar maple will increase following periods with higher rates of gap formation[216, 217].

V. F. 5. Great Lakes Water Level Fluctuations

The Great Lakes' water levels have fluctuated dramatically since record keeping started in the early 1900's. This fluctuation is primarily attributed to annual precipitation and evaporation rates within the Great lakes watersheds. In high water years, stands of emergent plants die off or become uprooted by wave and ice action. Strong onshore winds from a storm event can produce waves strong enough to uproot thousands of plants and cause severe erosion. However, because of the flat landscape, historically, the marsh usually was able to migrate inland in shallow water areas that were once wet meadow. As the cycle continues, water levels eventually fall, allowing the rhizomes of emergent plants destroyed above ground to produce stems and recolonize shallower open water over time. This ecosystem dynamic known as "lateral displacement" (where vegetative zones expand and contract) sets back succession, accelerates nutrient cycling, increases habitat diversity and enhances coastal wetland values for wildlife.

FACT

Due to Lake St. Clair's relatively small surface area, its water levels can respond rapidly and fluctuate significantly in response to climatic factors and short-term weather events across the region.

Due to Lake St. Clair's relatively small surface area, its water levels can respond rapidly and fluctuate significantly in response to climatic factors and short-term weather events. The St. Clair River provides about 97 percent of the total water supply with drainage from the immediate watershed providing the other three percent. For this reason, the lake is particularly susceptible to even small changes in its connecting channels, the St. Clair and Detroit rivers.

Long-term changes in water levels on Lake St. Clair are usually the result of precipitation that is above or below average. Temperature and cloud cover, which drive evaporation, are also factors. Short-term changes in water levels on Lake St. Clair also occur when heavy rains fall on the Thames River watershed in Ontario and the Clinton River watershed in Michigan. Ice build-up in the St. Clair and Detroit Rivers has a major impact on Lake St. Clair water levels as it can restrict the flow in the St. Clair River by up to 50 percent, causing major changes to the Lake St. Clair inflows[218].

HIGHLIGHT

Water level fluctuations are critical to water, nutrient and energy exchange in coastal marsh wetlands.

Lake St. Clair had a record high of 175.78 meters in October, 1986, and a record low of 173.71 meters in January of 1936 - a difference of approximately 6 feet.

Between 1964 and 1998, average yearly water levels have steadily increased and the variance between the high and low peaks has decreased. In recent times however, lake levels have begun to decrease again. Lake St. Clair water levels decreased to 174.53 meters in March, 2003.

Wetland scientists have determined that water level fluctuations are critical to water, nutrient and energy exchange in coastal marsh wetlands. For example, during the breakdown of detritus (dead plant material), nutrients are released which are used for new plant growth. This process however, requires oxygen. De-watering of the marsh during low water periods allows wetland bottom soils to aerate, which increases detritus breakdown and nutrient exchange.

Section V Endnotes

1. Pebbles V. 2001. Linking Brownfields Redevelopment and Greenfields Protection for Sustainable Development. Great Lakes Commission. Ann Arbor, Michigan.

2. National Oceanic and Atmospheric Administration (NOAA), 1995 - 2000. Coastal Change Analysis Data for the Lower Peninsula of Michigan and Lake St. Clair Shoreline of Southern Ontario. National Oceanic and Atmospheric Administration Coastal Services Center, Charleston, SC. 1995-2000.

3. MacDonagh-Dumler, J., V. Pebbles and J. Gannon, 2003. North American Great Lakes Experience: Management Issues and Challenges. Draft. Presented at the International Lake Environment Committee / LakeNet Regional Workshop for Europe, Central Asia and the Americas in Burlington, VT, June 2003. www.worldlakes.org/uploads/Great_Lakes_24Dec03.pdf

4. NOAA, 1995 - 2000 *op. cit.*

5. Huron River Watershed Council, 2000. Runoff as resource. HRWC, funded in part by MDEQ and EPA. Ann Arbor, MI.

6. Patchett, J. M., & Wilhelm G. S., 1999. The ecology and culture of water. Conservation Design Forum. Elmhurst, Il. Accessed Nov 24, 2004: www.cdfinc.com/CDF_Resources/Ecology_and_Culture_of_Water.pd

7. USEPA, 1993. Natural Wetlands and Urban Stormwater: Potential Impacts and Management. USEP, Office of Wetlands, Oceans and Watersheds, Wetlands Division. Washington, DC.

8. Huron River Watershed Council, 2000, *op. cit.*

9. MDEQ-Surface Water Division Website, 2004. Stormwater. Accessed 16 December, 2004: www.michigan.gov/deq/0,1607,7-135-3313_3682_3716---,00.html

10. MDEQ Surface Water Quality Division, 1998. Guidebook of Best Management Practices for Michigan Watersheds. MDEQ Surface Water Quality Division. Accessed 16 December 2004 at: www.michigan.gov/deq/0,1607,7-135-3313_3682_3716-103496--,00.html

11. Huron River Watershed Council, 2000, *op. cit.*

12. Ferguson, B. K., 1998. Introduction to stormwater: concept, purpose, design. John Wiley and Sons. New York.

13. Costanza, Robert, d'Arge, Ralph, de Groots, Rudolph, Farber, Stephen, Grasso, Monica, Hannon, Bruce, Limburg, Karin, Naeem, Shahid, O'Neill, Robert. V., Paruelo, Jose, Raskins, Robert G., Sutton, Paul, & Marjan van den Belt, 1997. The value of the world's ecosystem services and natural capital. Nature, 387: 253-260.

14. MacArthur, Robert H., & Edward O. Wilson, 1967. The Theory of Island Biogeography. Princeton University Press, Princeton.

15. Turner, Monica Goigel, 1989. Landscape Ecology: The Effect of Pattern on Process. Annual Review of Ecology and Systematics, 20: 171-197.

16. Bender, Darren J., Contreras, Thomas A., & Lenore Fahrig, 1998. Habitat loss and population decline: a meta-analysis of the patch size affect. Ecology 79(2): 517-533.

17. Temple, Stanley A., & John R. Cary, 1988. Modeling dynamics of habitat-interior bird populations in fragmented landscapes. Conservation Biology, 2(4): 340-347.

18. Alverson, William S., Waller, Donald M., & Stephen L. Solheim, 1988. Forests too deer: edge effects in northern Wisconsin. Conservation Biology, 2(4):348-358.

19. Templeton, A. R., Shaw, K., ROutman, E., Davis, S.K., 1990. The Genetic Consequences of Habitat Fragmentation. Annals of the Missouri Botanical Garden, 77:1 (13-27).

20. MacArthur & Wilson, 1967, *op. cit.*

21. Kery, Marc, Matthies, Diethart, & Hans-Heinrich Spillman, 2000. Reduced fecundity and offspring performance in small populations of the declining grassland plants Primula veris and Gentiana lutea. The Journal of Ecology, 88: 17-30.

22. Menges, Eric S., 1991. Seed germination increases with size in a fragmented prairie species. Conservation Biology, 5(2): 158-164.

23. Cohen, J.G. 2001. Natural community abstract for oak barrens. Natural Features Inventory, Lansing, MI. 9 pp.

24. Nuzzo, V. 1986. Extent and status of Midwest oak savanna: Presettlement and 1985. Natural Areas Journal 6: 6-36.

25. Albert, D. A., and M. A. Kost. 1998. Natural community abstract for lakeplain wet prairie. Michigan Natural Features Inventory, Lansing, MI. 4 pp.

26. Day, G.M. 1953. The Indian as an ecological factor in the Northeastern forest. Ecology 34(2): 329-346.

27. Packard, S., & Mutel, C. F., 1997. The Tallgrass Restoration Handbook: For Prairies, Savannas, and Woodlands. Society for Ecological Restoration by Island Press. Washington, D.C.

28. Abrams, M.D. 1992. Fire and the development of oak forests. BioScience 42(5): 346-353.

29. Williams, M., & Hull, J., 1992. A Continuity of Tradition; a place where Native Americans still burn the prairies and oak openings. Restoration and Management Notes 10:1 (Summer).

30. Jacobs, C., 2004. Walpole Island: Issues Paper. Draft prepared for the Great Lakes Commission.

31. *Ibid.*

32. *Ibid.*

33. *Ibid.*

34. NOAA, 1995 - 2000 *op. cit.*

35. Jacobs, C., 2004, *op. cit.*

36. See Sustainable Agriculture Research and Education at http://www.sare.org/ncrsare

37. For U.S. federal programs, see http://www.nrcs.usda.gov/programs

38. NOAA, 1995 - 2000 *op. cit.*

39. USEPA, 2004. NPDES: Concentrated Animal Feeding Operations (CAFO) – Final Rule website. Accessed 17 Dec. 04: http://cfpub.epa.gov/npdes/afo/cafofinalrule.cfm

40. Meiman, James and Schmidt, Larry., comps. 1994. A Research Strategy for Studying Stream Processes and the Effects of Altered Streamflow Regimes. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station.

41. Ouyang, D. and Bartholic, J. 2003. Soil Erosion and Sediment Assessment in the Great Lakes Basin.. Michigan State University, Institute of Water Research.

42. Researchers at Michigan State University are currently using advanced modeling techniques to calculate soil erosion, sediment delivery ratio, and sediment load for tributary watersheds of the Great Lakes. As monitored sediment data is not readily available in many cases, modeling of erosion and sediment delivery ratios is an important and effective approach to estimate sediment loading. Using Geographical Information System (GIS) technology and GIS data layers such as digital elevation model (DEM), land use/cover and soils, models can be efficiently used to simulate soil erosion, sediment delivery and loading for identifying high contributing areas in a large basin. MSU researchers are developing a "broad-brush analysis" of Great Lakes watersheds in order to assess and compare their relative loadings of sediments, state of conservation practices, and their potential for further reductions to sediment and contaminant loadings.

43. Ribaudo, M.O., and D. Hellerstein. 1992. Estimating Water Quality Benefits: Theoretical and Methodological Issues. TB 1808. U.S. Dept. Agr., Econ. Res. Serv., August. www.ers.usda.gov/publications/tb1808/

44. Castro, J. and F. Reckendorf (1995), *Effects of Sediment on the Aquatic Environment*, Resource Conservation Act (RCA) III, Working Paper No. 6, Natural Resources Conservation Service, US Department of Agriculture, Washington, D.C., United States.

45. Ardizone, K. A., 2003. Filling the Gaps: Environmental Protection Options for Local Governments. A joint publication of MDEQ's Coastal Management Program, NOAA, Planning and Zoning Center,& MDNR. Also available online - Accessed 12/06/04 www.michigan.gov/deq/0,1607,7-135-3313_3677_3696---,00.html

46. MDEQ website, 2004. Wetland Permits. Accessed 12/07/04: www.michigan.gov/deq/0,1607,7-135-3313_3687-10813--,00.html

47. Ardizone, K. A., 2003, *op. cit.*

48. Quinn, Frank H. 1985. Temporal Effects of St. Clair River Dredging on Lakes St. Clair and Erie Water Levels and Connecting Channel Flow. Journal of Great Lakes Research. 11(3): 400-403. International Association of Great Lakes Researchers, 1985.

49. St. Clair River Stage 1 Remedial Action Plan Report, p.18. www.friendsofstclair.ca/pdf/rap1.pdf

50. St. Clair River – Lake St. Clair Comprehensive Management Plan, Final Draft, June 2004

51. See e.g., Rule No. 281.925, Michigan Code of Administrative Rules.

52. 1994 P.A. 451 Part 303. See Rule No. 281.951, Michigan Code of Administrative Rules.

53. Ardizone, K. A., 2003, *op. cit.*

54. *Ibid.*

55. SOLEC Coastal Wetlands, Background Paper, 1997

56. Quinn, 1985, *op. cit.*

57. Quinn, 1985, *op. cit.*

58. Civil Works Digital Project Notebook website. Accessed 17 Dec. 04: http://crunch.tec.army.mil/dpn/webpages/dpndetail.cfm?ID=167&ACC=1

59. SOLEC Coastal Wetlands, Background Paper, 1997

60. SOLEC Coastal Wetlands, Background Paper, 1997

61. Wilcox, D.A. 1995. The role of wetlands as nearshore habitat in Lake Huron. In: Munawar, M., Edsall, T., Leach, J. (eds.), The Lake Huron Ecosystem: Ecology, Fisheries and Management. pp. 223-245. SPB Academic Publishing, Amsterdam, The Netherlands.

62. SOLEC Coastal Wetlands, Background Paper, 1997

63. www.epa.gov/waterscience/standards/nutstra3.pdf

64. www.epa.gov/waterscience/standards/nutstra3.pdf

65. In the United States, 50% of the lakes and 60% of rivers have impaired water quality due to excess nutrients from agricultural runoff. www.ars.usda.gov/research/programs/programs.htm?np_code=201&docid=340&page=2

66. St. Clair River – Lake St. Clair Comprehensive Management Plan, Final Draft, June 2004

67. SEMCOG, Land Use Changes in Southeast Michigan, 1990-2000

68. An animal feeding operation is a facility where farm animals are in a confined or concentrated situation for at least 45 days out of any 12-month period and where vegetation is not sustained.

69. The MDEQ is taking steps to implement the new federal NPDES regulations for CAFOs. A stakeholder committee consisting of environmental interest groups, local government associations, agricultural industrial commodity groups, and state and federal agencies developed proposed changes to Michigan's Wastewater Discharge Permit targeted for the fall of 2004.

70. Research by Edsall 1996 as well as by Wilcox & French 1996 revealed that plant nutrients in the water column and in the sediments were high enough to produce the growth of the plant material. Other research by Fox (1995) indicated that storms during the early summer could have caused the detachment of the submersed plants, and using a drift model, showed the possibility of rafting on the western shorelines. Another potential cause for the 1994 accumulation of floating plant mats were the discharges of the combined sewer overflows (CSOs) along the Red Run and near the mouth of the Clinton River.

71. Macomb County was utilizing five CSO basins that discharged a mixture of stormwater and sewage water into Lake St. Clair. These CSO facilities include the Chapatron, Martin, Milk River, St. Clair Shores, and Twelve Towns Basins.

72. www.epa.gov/waterscience/criteria/nutrient/strategy.html

73. From: www.ars.usda.gov/research/programs/programs.htm?np_code=201&docid=340&page=2

74. The U.S. EPA's ECOTOX (ECOTOXicology) database provides single chemical toxicity information for aquatic and terrestrial life and is a useful tool for examining impacts of chemicals on the environment. It is online at: www.epa.gov/ecotox/

75. Bioaccumulation is the accretion of chemicals in animal tissue at levels greater than those in the water or soil to which they were applied.

76. Biomagnification is the accumulation of chemicals at each successive level of the food chain. At each step in the food chain the concentration of the chemical increases.

77. Aulerich, R.J., Ringer, R.K., and S. Iwamoto. 1973. Reproductive failure and mortality in mink fed on Great Lakes fish. Journal of Reproduction and Fertility (Supplement) 19, 365-376.

78. Kubiak, T.J., Harris, H.J., Smith, L.M., Schwartz, T.R., Stalling, J.A., Trick, J.A., Sileo, L., Docherty, D.E., and T.C. Erdman. 1989. Microcontaminants and reproductive impairment of the Forster's tern on Green Bay, Lake Michigan. 1983. Archives of Environmental Contamination and Toxicology 18, 706-727.

79. Colborn, T. 1991. Epidemiology of Great Lakes bald eagles. Journal of Toxicology and Environmental Health 33, 395-454.

80. Wren, C.D. 1991. Cause-effect linkages between chemicals and populations of mink (Mustella vison) and otter (Lutra canadensis) in the Great Lakes basin. Journal of Toxicology and Environmental Health 33, 549-586.

81. Wren, C.D. 1991. Cause-effect linkages between chemicals and populations of mink (Mustella vison) and otter

    (Lutra canadensis) in the Great Lakes basin. Journal of Toxicology and Environmental Health 33, 549-586.

82. Hoffman, D.J., Smith, G.J., and B.A. Rattner. 1993. Biomarkers of contaminant exposure in common terns and black-crowned night herons in the Great Lakes. Environmental Toxicology and Chemistry 12, 1095-1103.

83. Giesy, J.P., et al. 1994. Contamination in fishes from Great Lakes influenced sections and above dams of three Michigan rivers. II. Implications for the health of mink. Archives of Environmental Contamination and Toxicology 27, 213-223.

84. Bishop, C.A., Brooks, C.N., Carey, J.H., Ng, P., Nostrom, R.J., and D.R.S. Lean. 1991. The case for a cause-effect linkage between environmental contamination and development in eggs of the common snapping turtle Chelydra serpentina serpentina from Ontario. Canadian Journal of Toxicology and Environmental Health 33, 521-548

85. SOLEC Coastal Wetlands, Background Paper, 1997

86. Dodge, D. and R. Kavetsky. 1995. Aquatic Habitat and Wetlands of the Great Lakes. 1994 State of the Lakes Ecosystem Conference (SOLEC) Background Paper. Environment Canada and United States Environmental Protection Agency EPA 905

87. Solomon, K.R., Baker, D.B., Richards, R.P., Dixon, K.R., Klaine, S.J., La Point, T.W., Kendall, R.J., Weisskopf, C.P., Giddings, J.M., Giesy, J.P., Hall, L.W.Jr., and W.M. Williams. 1996. Ecological risk assessment of atrazine in North American surface waters. Environmental Toxicology and Chemistry 15, 31-76.

88. SOLEC Coastal Wetlands, Background Paper, 1997.

89. Wilcox, D.A. 1985b. The effects of deicing salts on vegetation in Pinhook Bog, Indiana. Canadian Journal of Botany 64, 865-874.

90. The MDEQ provides primary regulatory oversight of industrial discharges under the Federal Clean Water Act and the Michigan Natural Resources and Environmental Protection Act. Discharges from Canadian chemical manufacturing and petrochecmical processing industries are regulated by various provincial and federal laws, including the Ontario Water Resources Act (OWRA) and the provincial Clean Water Regulations. The OMOE Environmental Compliance Report reports noncompliance for municipal plant discharging in the region and can be found online at: www.ene.gov.on.ca/envision/compliance/compliance.htm.

91. U.S. industrial permittees in the study area are in compliance with the discharge permits issued to them by the Michigan Department of Environmental Quality (MDEQ) There are minor exceedances of permit conditions at facilities within the watershed but these exceedances are not formally actionable under the enforcement guidance used by the department (MDEQ staff, LSC Management Plan).

92. In the past, spills have had a large impact on environmental quality of Lake St. Clair. The number and size of spills or releases has reduced dramatically over the last several years due to measures implemented by both U.S. and Canadian industries. Between 1990 and 2001, spills on the U.S. side decreased from 28 to 18 annually. Canadian records indicate an even greater reduction, from between 70 and 135 spills annually between 1986 and 1989, to between seven and 12 spills between 1998 and 2002.

    Two plans mandate the procedures and mechanisms for a joint binational notification and response to spills of oil or hazardous substances in the Lake St. Clair region. The first is Annex I of the Canada-United States Joint Marine Pollution Contingency Plan (CANUSLAK) which was mandated under Annex 9 of the Great Lakes Water Quality Agreement. The second is Annex III of the Canada-United States Joint Inland Pollution Contingency Plan (CANUSCENT). Each of these plans establishes fundamental procedures for timely notification and coordinated and integrated response at the federal level of each government.

    Formal cross-border notification procedures have also been adopted and are implemented through the U.S. National Response Center and the Canadian National Environmental Emergencies Centre, as well as the Ontario Ministry of the Environment Spills Action Centre and the Emergency Management Division of the Michigan State Police. The United States Coast Guard and the Canadian Coast Guard have a similar working arrangement and share information with the provincial and state agencies. Water treatment operators also use an informal reporting system. A water intake operator who hears about a spill, or is impacted by an unknown spill, immediately calls the next facility on the "notification list" who in turn calls the next facility, and so on.

    Individually, both the United States and Canada have existing mechanisms in place to respond to and manage the actions required during an oil and hazardous substance spill at the federal, state/provincial, and local level.

93. The MDEQ has regulatory oversight for all municipal wastewater treatment plants on the U.S. side of Lake St. Clair. All plants in watershed are in compliance with their discharge permit requirements although many are on specified compliance schedules to correct problems with their local sanitary sewers. The MDEQ has reported that there are minor exceedances of permit conditions at facilities within the watershed but that none of these exceedances are formally actionable under the enforcement guidance used by the department. When minor exceedances occur, MDEQ staff contact the facilities to determine the cause and assure that corrective actions have been taken.

    The Ontario Ministry of the Environment (OMOE) has regulatory oversight for treatment plants in the Canadian portion of the watershed. Over thirty municipal water pollution control plants (WPCPs) are located along the tributaries entering Lake St. Clair on the Ontario side. Another two municipal wastewater treatment plants discharge directly into the lake. The OMOE Environmental Compliance Report reports noncompliance for municipal plant discharging in the region.

94. www.epa.gov/glnpo/bns/index.html

95. U.S. Environmental Protection Agency. 1997. The incidence and severity of sediment contamination in surface waters of the United States: The National Sediment Quality Survey. USEPA. http://www.epa.gov/OST/cs/report.html (Last visited 8/27/04)

96. International Joint Commission [IJC]. 1985. 1985 Report of Great Lakes Water Quality. The International Joint Commission, Water Quality Board, Windsor, Ontario, Canada.

97. International Joint Commission [IJC]. 1985, *op. cit.*

98. Rheume, et. al., 2000, *op. cit.*

99. *Ibid.*

100. *Ibid.*

101. Bertram, Paul E., Edsall, Thomas A., Manny, Bruce A., Nichols, Susan J., Schloesser, Donald W. 1991. Chemical Contamination and Physical Characteristics of Sediments in the Upper Great Lakes connecting Channels: 1985. 1990. US Environmental Protection Agency No. EPA-905/9-91-018. Great Lakes National Program Office, Chicago.

102. Smith, S.L., MacDonald, D.D., Keenleyside, K.A., Ingersoll, C.G., and Field, L.J., 1996, A preliminary evaluation of sediment quality assessment values for freshwater ecosystems: Journal of Great Lake Research 22: 624-638.

103. U.S. Environmental Protection Agency, 1997, *op. cit.*

104. U.S. Environmental Protection Agency, 1997, *op. cit.*

105. International Joint Commission [IJC]. 2003, *op. cit.*

106. International Joint Commission [IJC]. 2003, *op. cit.*

107. Associated Press, 2004. Researchers: Beach grooming may damage Michigan lakes: They say plant growth that results from low water levels is vital. Detroit News, Friday, May 14, 2004. Accessed 20 Dec. 2004: www.detnews.com/2004/metro/0405/15/c02-152797.htm

108. Mertz, L. , 2003. Property Rights or Wetlands Wronged? *Senate considers claim to "groom" beaches*. Great Lakes Bulletin News Service 5/18/2003. Accessed on the Michigan Land Use Institute website on 20 Dec. 2004: www.michigan.gov/deq/0,1607,7-135-3313_3677-70142--,00.html

109. Shafer, C., 2004. Testimony before the Michigan Senate Regarding Additional "Beach Grooming" Activities on Great Lakes Bottomlands, May 11, 2004. Accessed 20 Dec. 2004: www.michiganwetlands.org/shafer_testimony.pdf

110. An emergent wetland is a wetland class, including marshes and wet meadows, dominated by emergent plants (i.e., water plants with roots and part of the stem submerged below water level, but the rest of the plant is above water; cattails and bulrushes, for example).

111. MDEQ website: Great Lakes beach maintenance. Accessed 20 Dec. 2004: www.michigan.gov/deq/0,1607,7-135-3313_3677-70142--,00.html

112. Please note that a permit from the U.S. Army Corps of Engineers is still needed for most activities that alter Great Lakes Coastal areas including vegetation removal, beach leveling and path construction.

113. Alger, G.R. 1979. Ship-induced waves, ice and physical movement on the St. Marys River. Draft report of project 5100 to the Great Lakes Basin Commission. Ann Arbor, MI.

114. Haslam, S. M. 1978. River plants. Cambridge Univ. Press.

115. Schloesser, D. W. and Manny, B. A. (1982) Distribution and Relative Abundance of Submerged Aquatic Macrophytes in the St. Clair-Detroit River Ecosystem. U.S. Fish and Wildlife Service, Great Lakes Fisheries Laboratory. Ann Arbor, MI. (USFWS-GLFL/AR-82-7) pp. 49

116. Westlake, D. F. 1975. Macrophytes. In: B.A. Whitton (ed.) River ecology. University of California Press: Berkeley. pp. 106-28.

117. Schloesser and Manny 1982 *op. cit.*

118. Jude, D. J., M. Winnell, M. S. Evans, F. J. Tesar, and R. Futyma. 1988. Drift of zooplankton, benthos, and larval fish and distribution of macrophytes and larval fish in the St. Marys River, Michigan, during winter and summer, 1985. The University of Michigan, Great Lakes Research Division, Special Report No. 124, Ann Arbor.

119. Poe, T. P., and T. A. Edsall. 1982. Effects of vessel-induced waves on the composition and amount of drift in an ice environment in the St. Marys River. U. S. Fish and Wildlife Service, Great Lakes Fishery Laboratory, Administrative Report No. 82-6, Ann Arbor.

120. Poe, T. P., T. A. Edsall, and J. K. Hiltunen. 1980. Effects of ship-induced waves in an ice environment on the St. Marys River ecosystem. U. S. Fish and Wildlife service, Great Lakes Fishery Laboratory Administrative Report 80-6, Ann Arbor.

121. Mahoney, E., Stynes, D., Chang, T-C, and McCelleis, T. (2002) The Economic Importance of Michigan's Recreational Boating Industry.

122. Edsall, T.A., Manny, B.A., and Raphael, C.N. 1988. The St. Clair River and Lake St. Clair, Michigan: an ecological profile. Biol. Rep. No. 85(7.3). U.S. Fish and Wildlife Service, Washington, D.C.

123. Manny, BA, Edsall, TA, & Jaworski, E. 1988. The Detroit River, Michigan : an ecological profile. National Wetlands Research Center, Fish and Wildlife Service, U.S. Dept. of Interior.

124. Prince and Associates Ltd. (2002) County of Essex Official Plan. Draft. Corporation of the County of Essex. Essex County Ontario.

125. Mauvais J. L., 1991. - Les ports de Plaisance. Impacts sur le Littoral , IFREMER édit., 89 p.

126. Drolet, R. 1998. Rapport sur l'etat du Saint-Laurent – Le derangement des especes faunique du Saint-Laurent. Technical Report. Federal-provincial SOE team composed of representatives of Environment Canada, Fisheries and Oceans Canada and the Ministere de LEnvironment et de la faune du Quebec, Sainte Foy.

127. Robert Beltran, 2004. University of Chicago Library Exhibit: Invaders of the Great lakes. Accessed 12/1/04. www.lib.uchicago.edu/e/crerar/exhibits/greatlakes3.html

128. Davis & Thompson, 2000, Eight Ways to be a Colonizer; Two Ways to be an Invader: A Proposed Nomenclature Scheme for Invasion Ecology. Bulletin of the Ecological Society of America. p.227.

129. Westbrooks, R. 1998. Invasive plants, changing the landscape of America: Fact book. Federal Interagency Committee for the Management of Noxious and Exotic Weeds (FICMNEW), Washington, D.C. 109 pp.

130. Kafcas, E. 2004. Restoration of Phragmites Dominated Wetlands inn SE Michigan Great Lakes Marsh Ecosystem. Unpublished Draft - Michigan Department of Natural Resources.

131. Chesky, E.D. and Wilson, W.G. (2001). (Eastern Lake St. Clair Important Bird Area Conservation Plan November. Produced for the Eastern Lake St. Clair IBA Steering Committee and Stakeholders.

132. Marks, Marianne (original version), Beth Lapin & John Randall (1993 update). 1993. Element Stewardship Abstract For *Phragmites australis*. The Nature Conservancy.

133. Maine Natural Areas Program. Invasive Plant Fact Sheet: Purple Loosestrife. Department of Conservation Web site. Accessed January, 2004.

134. Michigan State University Purple Pages. www.miseagrant.umich.edu/pp/the_project.html. Accessed December, 2004.

135. Michigan State University Purple Pages. www.miseagrant.umich.edu/pp/the_project.html. Accessed December, 2004.

136. Anchor Bay Watershed Project. Anchor Bay Watershed Management Plan, Draft 2003. Accessed December, 2003: http://awp.stclaircounty.org/StateoftheWatershed.pdf

137. U.S. Geological Survey, Great Lakes Science Center. Sea Lamprey Web Page. Accessed December, 2004: www.glsc.usgs.gov/main.php?content=research_lamprey&title=Invasive%20Fish0&menu=research_invasive_fish

138. U.S. Geological Survey, Great Lakes Science Center. Sea Lamprey Web Page. Accessed December, 2004: www.glsc.usgs.gov/main.php?content=research_lamprey&title=Invasive%20Fish0&menu=research_invasive_fish

139. Chesky, E.D. and Wilson, W.G. (2001). (Eastern Lake St. Clair Important Bird Area Conservation Plan November. Produced for the Eastern Lake St. Clair IBA Steering Committee and Stakeholders.

140. Batcher, M. S. and Stiles, S. A., 2000. ELEMENT STEWARDSHIP ABSTRACT for the bush honeysuckles. TNC Weeds Website. Accessed 19 December 2004: http://tncweeds.ucdavis.edu/esadocs/loni_spp.html

141. Converse, C. K. 1984. ELEMENT STEWARDSHIP ABSTRACT for *Rhamnus cathartica*, *Rhamnus frangula* (syn. *Frangula alnus*) Buckthorns. TNC Weeds website. Accessed 19 Dec. 2004: http://tncweeds.ucdavis.edu/esadocs/documnts/franaln.html

142. Batcher, M. S., 2000. ELEMENT STEWARDSHIP ABSTRACT for *Ligustrum spp*. Privet. TNC Weeds website. Accessed 19 Dec. 2004: http://tncweeds.ucdavis.edu/esadocs/documnts/ligu_sp.html

143. Sather, N., Eckardt, N.,1987. ELEMENT STEWARDSHIP ABSTRACT for *Elaeagnus umbellata* Autumn Olive. TNC Weeds website. Accessed 19 Dec. 2004: http://tncweeds.ucdavis.edu/esadocs/documnts/elaeumb.html

144. Nuzzo, V., 2000. ELEMENT STEWARDSHIP ABSTRACT for *Alliaria petiolata* Garlic mustard. TNC Weeds website. Accessed 19 Dec. 2004: http://tncweeds.ucdavis.edu/esadocs/documnts/allipet.html

145. Eckhardt, N., 1987. ELEMENT STEWARDSHIP ABSTRACT for *Melilotus officinalis, Melilotus alba*: Sweetclover. TNC Weeds website. Accessed 19 Dec. 2004: http://tncweeds.ucdavis.edu/esadocs/documnts/melioff.html

146. Mauer, T., Russo, M., Evans, M., 1987. ELEMENT STEWARDSHIP ABSTRACT for *Centaurea maculosa* Spotted Knapweed. TNC Weeds website. Accessed 19 Dec. 2004: http://tncweeds.ucdavis.edu/esadocs/documnts/centmac.html

147. Sather, N., 1987. ELEMENT STEWARDSHIP ABSTRACT for *Bromus inermis* Awnless Brome, Smooth Brome. TNC Weeds website. Accessed 19 Dec. 2004: http://tncweeds.ucdavis.edu/esadocs/documnts/bromine.html

148. Emerald Ash Borer a Growing Concern. St. Clair Region Conservation Authority Media release. October 16, 2003. Accessed January, 2004: www.scrca.on.ca/Media_EmeraldAshBorerFactSheet.htm.

149. USDA Forest Service, 2004. Emerald Ash Borer Home Page. Accessed 11/06/04: www.na.fs.fed.us/spfo/eab/

150. Campbell. F. T. 2004. TNC's Gallery of pests: Emerald Ash Borer. Accessed 19 Dec. 2004: http://tncweeds.ucdavis.edu/products/gallery/agrpl1.html

151. USDA Animal and Plant Health Inspection Service. Asian Longhorned Beatle, Plant Protection and Quarantine. January 2001. www.licweb.com/asianbeetle/usda/fsalb.html. Accessed January, 2004.

152. USDA ARS BIIR ALB Site: http://ag.udel.edu/other_websites/biir/anoplophora/default.htm. Accessed January, 2004.

153. Pennsylvania Sea Grant. Eurasion Ruffe Fact Sheet. www.pserie.psu.edu/seagrant/communication/fact/fs9.html. Accessed December, 2004.

154. Pennsylvania Sea Grant. Eurasion Ruffe Fact Sheet. www.pserie.psu.edu/seagrant/communication/fact/fs9.html. Accessed December, 2004.

155. St. Clair River – Lake St. Clair Comprehensive Management Plan, Final Draft, June 2004.

156. St. Clair River – Lake St. Clair Comprehensive Management Plan, Final Draft, June 2004

157. USFWS, 2004. Study Outlines Options for Agencies to Slow Asian Carp Invasion. Accessed 19 Dec.2004: http://news.fws.gov/newsreleases/r3/E36B1D83-C995-4ADA-B6DCCDF8EF0266B6.html

158. USEPA, 2004. Asian Carp and the Great Lakes. Accessed 19 December, 2004: www.epa.gov/glnpo/invasive/asiancarp/

159. *Ibid.*

160. Pam Fuller, 2004, *Channa argus*. Nonindigenous Aquatic Species Database, Gainesville, FL. Revision Date: 7/23/04. Accessed: 12/06/04 http://nas.er.usgs.gov/queries/SpFactSheet.asp?speciesID=2265

161. Barringer, Felicity, 2004. Spawning of Interloper Fish In Potomac Worries Experts. New York Times, 11/03/04: Page 12.

162. U.S. Fish and Wildlife Service. Recognizing Northern Snakehead. http://midwest.fws.gov/fisheries/library/fact-snakehead.pdf. Accessed December, 2004.

163. Illinois-Indiana Sea Grant, 2003. Hydrilla (*Hydrilla verticillata*). Accessed 19 December 2004: www.iisgcp.org/EXOTICSP/hydrilla.htm#intro

164. van Dijk, G. 1985. Vallisneria and its interactions with other species. Aquatics 7(3):6-10.

165. Michigan Sea Grant, 2003. Heading off hydrilla: *invasive species is heading towards the Great Lakes: Hydrilla verticillata*. Accessed 19 Dec. 2004: www.miseagrant.org/ais/hydrillafactsheet.pdf

166. Colle, D.E. and J.V. Shireman. 1980. Coefficients of condition for largemouth bass, bluegill, and redear sunfish in hydrilla-infested lakes. Transactions of the American Fisheries Society 109:521-531.

167. USGS, 2003. *Hydrilla verticillata*. Accessed 19 December 2004: http://nas.er.usgs.gov/plants/docs/hy_verti.html

168. Michigan Sea Grant, 2003, *op. cit.*

169. Great Lakes Commission (2004) ANS Early Detection and Monitoring: A Pilot Project for the Lake Michigan Basin, Draft.

170. Wilcox, Kerrie L.; Scot A. Petrie, Laurie A. Maynard and Shawn W. Meyer (2003) Historical Distribution and Abundance of *Phragmites australis* at Long Point, Lake Erie, Ontario. J. Great Lakes Res. 29(4):664-680. 2003. Internat. Assoc. Great Lakes Res.

171. Maine Natural Areas Program. Invasive Plant Fact Sheet: Japanese Knotweed. Department of Conservation Web site (accessed January, 2004).

172. Chesky, E.D. and Wilson, W.G. (2001). (Eastern Lake St. Clair Important Bird Area Conservation Plan November. Produced for the Eastern Lake St. Clair IBA Steering Committee and Stakeholders.

173. Schloesser, D.W., and B.A. Manny. 1984. Distribution of Eurasian watermilfoil, Myriophyllum spicatum, in the St. Clair-Detroit River system in 1978. Journal of Great Lakes Research 10:322-326.

174. Daniels, J. 2000. European Frogbit: What is it? Should we be worried? Michigan Sea Grant College Program, Upwellings 22(4).

175. Michigan State University Purple Pages. http://www.miseagrant.umich.edu/pp/the_project.html. Accessed December, 2004.

176. Laird, C. A., and L. M. Page. 1996. Non-native fishes inhabiting the streams and lakes of Illinois. Illinois Natural History Survey Bulletin 35(1):1-51.

177. Hrabik, Thomas R. ,John J. Magnuson, and Ann S. McLain Can Predicting the effects of rainbow smelt on native fishes in small lakes: evidence from long-term research on two lakes. . J. Fish. Aquat. Sci./J. Can. Sci. Halieut. Aquat. 55(6): 1364-1371 (1998)

178. U.S. Geological Survey, Great Lakes Science Center. Sea Lamprey Web Page. Accessed December, 2004: www.glsc.usgs.gov/main.php?content=research_lamprey&title=Invasive%20Fish0&menu=research_invasive_fish

179. USDA, NRCS. 2004. The PLANTS Database, Version 3.5 (http://plants.usda.gov). National Plant Data Center, Baton Rouge, LA 70874-4490 USA.

180. USDA, NRCS. 2004. The PLANTS Database, Version 3.5 (http://plants.usda.gov). National Plant Data Center, Baton Rouge, LA 70874-4490 USA.

181. USDA, NRCS. 2004. The PLANTS Database, Version 3.5 (http://plants.usda.gov). National Plant Data Center, Baton Rouge, LA 70874-4490 USA.

182. Nowierski, R. M. and S. J. Harvey. 1988. Vegetation Composition at Four Rangeland Sites Infested by Leafy Spurge. MSU Biology Report No. 40. Montana State University, Bozeman, Montana, USA.

183. Belcher, J. W. and S. D. Wilson. 1989. Leafy spurge and the species composition of a mixed- grass prairie. Journal of Range Management 42: 172-175.

184. Wallace, N. M., J. A. Leitch, and F. L. Leistritz. 1992. Economic Impact of Leafy Spurge on North Dakota Wildland. Agricultural Economics Report No. 281, Agricultural Experiment Station, North Dakota.

185. Ciaranca, M.A., C.C. Allin, and G.S. Jones. 1997. .Mute Swan.. In The Birds of North America, No. 273. (A. Poole and F. Gill eds.). The Academy of Natural Sciences, Philadelphia, and the American Ornithologists. Union, Washington D.C.

186. Abell, 1934. Influence of glaze storms upon hardwood forests in the southern Appalachians. Journal of Forestry 32:35-37.

187. Lemon, 1961. Forest ecology of ice storms. Bulletin of the Torrey Botanical Club 88(1):21-29.

188. Melancon and Lechowicz, 1987. Differences in the damage caused by glaze ice on codominant *Acer saccharum* and *Fagus grandifolia*. Canadian Journal of Botany 65:1157-1159.

189. Melancon and Lechowicz 1987, *op. cit.*

190. Lemon 1961, *op. cit.*

191. Melancon and Lechowicz 1987, *op. cit.*

192. Abell 1934, *op. cit.*

193. Lemon 1961, *op. cit.*

194. Melancon and Lechowicz 1987, *op. cit.*

195. Melancon and Lechowicz 1987, *op. cit.*

196. Leach, M. K., and T. J. Givnish, 1996. Ecological determinants of species loss in remnant prairies. Science 273:1555-1558

197. Runkle 1982, *op. cit.*

198. Frelich and Lorimer, 1991. Natural disturbance regimes in hemlock-hardwood forests of the upper Great Lakes region. Ecological Monographs 61(2):145-164.

199. Canham and Loucks,1984. Catastrophic windthrow in the presettlement forests of Wisconsin. Ecology 65(3):803-809.

200. Runkle, 1984. Development of woody vegetation in treefall gaps in a beech-sugar maple forest. Holarctic Ecology 7:157-164.

201. Moore and Vankat 1986. Responses of the herb layer to the gap dynamics of a mature beech-maple forest. American Midland Naturalist 115(2):336-347.

202. Franklin et al., 1987. Tree death as an ecological process. Bioscience 37:550-556.

203. Runkle 1991, *op. cit.*

204. Runkle 1984, *op. cit.*

205. Runkle 1982, *op. cit.*

206. Poulson and Platt, 1989. Gap light regimes influence tree canopy diversity. Ecology 70(3):553-555.

207. Barnes, B. V., Zak, D. R., Denton, S. R. and S. H. Spurr, 1998. Forest Ecology. 4th edition. John Wiley and Sons, Inc., New York. 774 pp.

208. Runkle 1984, *op. cit.*

209. Barnes et al. 1998, *op. cit.*

210. Runkle 1982, *op. cit.*

211. Barnes et al. 1998, *op. cit.*

212. Runkle 1981, *op. cit.*

213. Runkle 1982, *op. cit.*

214. Runkle 1984, *op. cit.*

215. Poulson and Platt 1989, *op. cit.*

216. Canham, 1988. Growth and Canopy architecture of shade tolerant trees: response to canopy gaps. Ecology 69(3):786-795.

217. Poulson and Platt, 1996. Replacement patterns of beech and sugar maple in Warren Woods, Michigan. Ecology 77(4):1234-1253.

218. (GLERL – Quinn: www.glerl.noaa.gov/pubs/fulltext/2002/20020019.pdf

Section VI. Overarching Responses to Stressors

Responses to habitat stressors are the things people do to eliminate or mitigate those activities that stress or threaten habitat. The previous section of this Assessment discussed specific responses to specific stressors, such as invasive species programs, or soil erosion control programs. Many responses, however, are part of wide-ranging conservation and land management efforts. This section discusses those activities that are more broadly aimed at land conservation and restoration. Such programs are overarching and usually address a range of habitat stressors simultaneously. For example, merely acquiring land and keeping it from development can address the range of stressors associated with development, from habitat fragmentation to sediment and nutrient loadings.

HIGHLIGHT

The Lake St. Clair area has been targeted for increased habitat conservation and restoration by a by a number of organizations, which emphasize its globally imperiled natural communities, its importance as a staging area for migratory birds and as breeding habitat for protected species.

This section organizes these overarching responses to stressors into three general categories: 1) habitat management and restoration programs; 2) inventory and monitoring tools, and 3) planning.

Habitat management and restoration programs vary widely and include programs run by and for the public, those run by non-profits, such as conservancies and land trusts as well as public and non-profit programs aimed at providing private citizens and landholders with tools and information to improve conservation and land management practices. Inventory and monitoring tools provide essential baseline information to assess trends in habitat conditions as well as stressors. Local planning tools such as community master plans, natural features ordinances and overlay zones are critical to the preservation of natural areas within individual communities. When coordinated (e.g., at the county or watershed level), they are essential in the ensuring connectivity and consistency among local conservation efforts, such as through greenways.

The Lake St. Clair area has been targeted for increased habitat conservation and restoration by a by a number of organizations, which emphasize its globally imperiled natural communities, its importance as a staging area for migratory birds and as breeding habitat for protected species. At the 1996 State of the Lakes Ecosystem Conference (SOLEC), a Land of the Lakes background paper introduced the concept of Biodiversity Investment Areas to describe sections of shoreline with particularly high ecological values. At the 1998 SOLEC, specific areas were designated, including the entire Lake St. Clair/Detroit River corridor. The corridor merits particular attention to protect it from degradation; unique features cited included the area's lakeplain prairies, oak savannas and the St. Clair Flats[1].

FACT

The Eastern Habitat Joint Venture, a Canadian regional partnership established under the North American Waterfowl Management Plan has identified the Lake St. Clair area as one of Ontario's top priorities in conserving migratory wildfowl.

The Natural Areas Program of the Michigan Department of Natural Resources has recognized two sites within the project area: the Algonac prairie and savanna, which was proposed for legal dedication by Natural Resources Commission Resolution and St. John's wet prairie, which is recognized under the Nature Conservancy's Natural Areas Registry. The Eastern Habitat Joint Venture, a Canadian regional partnership established under the North American Waterfowl Management Plan has identified the Lake St. Clair area as one of Ontario's top priorities in conserving migratory wildfowl[2]. The Important Bird Areas Program of

the Canadian Nature Federation and Bird Studies Canada has identified the majority of the Canadian portion of the project area as an Important Bird Area because of its role as critical habitat for migratory waterfowl and shorebirds and also as breeding habitat for protected species such as King Rail, Black Tern, Forster's Tern and Least Bittern[3] and in the southeastern corner of the lake, the St. Clair National Wildlife Area has been designated a RAMSAR site[4]. Recognition of the area's significance alone is not sufficient to protect or increase habitat regionally, but many of these organizations are also involved in far more extensive habitat acquisition, management and restoration efforts.

VI. A. Existing Habitat and Land Management Programs

An incredible array of programs exists with the ultimate goal of conserving existing habitat and restoring additional habitat on public and private lands and public waterways. In some cases, programs provide funding for the acquisition of lands by state/provincial, regional or local entities. Other programs focus specifically on the fine details of managing or restoring particular parcels of land. Still others provide financial incentives and technical assistance to private land owners to help them improve habitat quality or conserve critical resources on their own lands.

HIGHLIGHT

The non-profit organization Restoring America's Estuaries has prepared a comprehensive account of federally funded restoration programs in the U.S., which is available online at **www.estuaries.org/objects/FFGFY2003FullFinalv2.pdf.**

While agencies, programs and their beneficiaries cover an incredible range, the most successful projects are characterized by a broad range of partners and networking between many different stakeholders. Additionally, they often address multiple concerns such as improving water quality, reducing soil erosion, providing habitat for a particular species or group of species, connecting existing habitat and/or increasing the acreage or quality of a particular natural community. The non-profit organization Restoring America's Estuaries has prepared a comprehensive account of federally funded restoration programs in the U.S., which is available online at: *www.estuaries.org/objects/FFGFY2003FullFinalv2.pdf*.

The following sections provide an overview of the existing areas with high quality habitat in the project area, their management plans, programs to facilitate the acquisition, conservation and restoration of additional lands and selected conservation and restoration efforts.

VI. A. 1. Walpole Island First Nation

The largest areas of high quality habitat in the project area occur on the territory of Walpole Island First Nation, ranging from tallgrass (lakeplain) prairie to oak savanna (lakeplain oak opening) to Carolinian Forest to Great Lakes marsh. Because their lands are so significant, they have already been described in greater detail as part of the characterization of natural community types within the project area in Section IV. (See case study in Section IV. A. 4. b.). As part of this Assessment, a Potential Conservation Area (PCA) analysis identified and prioritized undeveloped lands in terms of their habitat quality (See Section VI. C.) and the top-ranking sites were located on Walpole Island. Two sites received the maximum possible score and an additional three sites received just one point less, including the largest single parcel in the study area, comprised of 11,366 acres (4,600 hectares) of Great Lakes marsh on the southern portion of the island complex.

FACT

On Walpole Island much of the land has survived with its ecological functions and thriving populations of rare and endangered species intact.

It is a credit to the entire community that so much of the land has survived with its ecological functions intact and its populations of rare and endangered species thriving, particularly as it faces the same pressures of population growth, increased housing demand and need for economic development as its neighbors on both sides of the lake. Most of the prairie and savanna on the Island is held by private landholders, while the majority of the marsh is owned by Walpole Island band members collectively. Traditional management practices and cultural values are largely responsible for both the survival and high quality of the Island's natural areas, but in recent years, more formal management programs have been instituted as well[5].

> **HIGHLIGHT**
>
> Community input is seen as being of prime importance because actions are unlikely to be successful without endorsement from the population, whereas an engaged community will provide much of the habitat protection required.

The Natural Heritage Program of the Walpole Island Heritage Centre has undertaken a number of initiatives including inventorying plant and animal species, controlling invasive species such as purple loosestrife and sweet white clover and leasing significant private lands. Recent terrestrial programs have been funded largely by the federal Habitat Stewardship Program for Species at Risk, but partnerships with local universities and other organizations have provided additional resources. Partnerships with the Royal Ontario Museum and the National Water Research Institute of Environment Canada have been instrumental in inventorying and studying the Island's marshes and aquatic habitats.[6]

Habitat Stewardship Program for Species at Risk

As part of the National Strategy for the Protection of Species at Risk, the Canadian federal government established the Habitat Stewardship Program (HSP) for Species at Risk in 2000-2001, which funds projects that conserve and protect species at risk and their habitats.

The HSP provides funding to "stewards" for implementing activities that protect or conserve habitats for species designated by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as nationally "at risk" (endangered, threatened or of special concern). These activities must take place on private lands, provincial Crown lands, Aboriginal lands, or in aquatic and marine areas across Canada.

The Walpole Island Heritage Centre has developed an Ecosystem Recovery to provide a framework for existing stewardship efforts and plan for long-term management of the Island's natural areas. The Ecosystem Recovery Strategy is in the process (2005) of being presented to band members and the Walpole Island Band Council for community adoption.

Community input is seen as being of prime importance because actions are unlikely to be successful without endorsement from the population, whereas an engaged community will provide much of the habitat protection required. Traditional respect for the natural world and Native philosophies of interacting with nature are fundamental to the identity of First Nations and are considered sacred obligations; conservation or natural habitat issues cannot be separated from cultural issues within the community[7].

VI. A. 2. Public Land Management Programs

For public sector land managers, land trusts and conservancies, responses include finding resources to manage and enhance the land that they already control or acquiring additional lands to improve overall ecological function and connectivity. Levels of land management can vary tremendously between different land managers, but simple acquisition and protection of existing habitat is the first step to maintaining a network of lands in an undeveloped state. Although conservation and restoration planning will be discussed later in extensive detail (See Section VIII.), existing protected lands should provide the backbone of any regional conservation planning and a brief listing of most of the major parcels within the project area follows.

HIGHLIGHT

The St. Clair National Wildlife area, along with its neighboring private marshes, was the only Canadian site outside of Walpole Island First Nation to receive the maximum possible score in the Potential Conservation Area Report.

The Potential Conservation Area (PCA) analysis conducted as part of this project prioritized undeveloped lands throughout the project area in terms of their habitat quality (See Section VI. C.) and a number of these parcels are publicly held. In the Michigan portion of the project area, the state holds the vast majority of lands containing significant habitat, although the area also contains one Metro Park and a number of municipal and township parcels. Walpole Island First Nation, as discussed above, contains the most and highest quality habitat in the entire area. In the Ontario portion of the project area, the federal government holds the single largest parcel of high quality habitat, but there are also sizable provincial, municipal and Conservation Authority sites as well.

CASE STUDY

Proposed Wetland Restoration - Lake St. Clair[10]

The Eastern Habitat Joint Venture, a regional partnership of the North American Waterfowl Management Plan has identified the Lake St. Clair area as one of Ontario's top priorities for migratory waterfowl habitat conservation. Its Technical Committee has initiated a study investigating the possible socioeconomic and biological implications of undertaking a wetland restoration project of approximately 1,000 acres in the vicinity of the Canadian portion of the Lake St. Clair shoreline. The primary goal of the restoration project is to increase the availability of waterfowl staging habitat within approximately 8 km of the shore.

The study's objectives were to identify:

- The economic and social effects that the restoration of a wetland of this size will have on the local area, including agriculture, tourism and recreation
- The environmental benefits on local, regional and continental scales of restoring a wetland in this type of landscape and socioeconomic setting.

Results suggest that the proposed project would provide substantial environmental and social benefits and would provide high quality spring and fall staging habitat for resting and feeding migratory waterfowl. Restoration would include the acquisition of agricultural land, construction of three to six wetland cells separated by dykes and additional habitat types which could include mudflat, tallgrass prairie, swamp and upland forest. The project would be expected to provide habitat for 135 additional animal species and 399 plant species. Benefits for people would include enhanced recreational opportunities such as birding nature observation and hunting.

Ontario

The St. Clair National Wildlife Area (NWA) lies just north of the mouth of the Thames River and is part of a larger system of marshes that extends along the eastern shore of Lake St. Clair. Along with its neighboring private marshes, it was the only Canadian site outside of Walpole Island First Nation to receive the maximum possible score in the Potential Conservation Area Report (See Section VII. C. 4.). It was established in 1974, shortly after the passage of the Canada Wildlife Act, which authorized the establishment of National Wildlife Areas to conserve essential habitat for migratory birds and other wildlife in the national interest. NWAs are managed by the Canadian Wildlife Service, the unit of Environment Canada that is responsible for protecting and managing migratory birds, nationally significant habitat and endangered species and most (including the St. Clair NWA) have detailed management plans[8].

The St. Clair NWA occupies 603 acres (244 hectares) of marsh in the southeast corner of Lake St. Clair, just north of the Thames River. The entire marsh is diked and divided into two cells so that water levels can be manipulated independently. The marsh consists largely of cattails, but there are 40 small meadow communities scattered along sandy beach ridges, as well as patches of prairie vegetation. The variation in depth within the marsh results in a patchwork of meadow, emergents and open water and upland habitat with grasses, forbs and large trees occurs along the dikes[9]. Although the primary role of NWAs is conservation rather than recreation, the St. Clair NWA has a loyal following among regional birders and amenities include trails along the dike, an observation tower and educational materials. The Canadian Wildlife Service also manages two additional sites as part of the St. Clair NWA: the Bear Creek Unit, with an additional 107 acres (43.3 hectares), along the *Chenal Ecarte* and the recently acquired Pigeon Marsh (57 acres / 23.2 hectares), which abuts the Bear Creek Unit along the Sydenham River (personal communication, Gary McCullough, 2004).

North American Waterfowl Management Plan

The North American Waterfowl Management Plan is a strategy to restore waterfowl populations through habitat protection, restoration and enhancement. Developed in response to plummeting waterfowl populations and increased awareness of the wetland destruction, the plan represents an acknowledgment that waterfowl are the most prominent and ecologically important group of migratory birds in North America.

The plan is implemented by regional partnerships, called Joint Ventures, which involve federal, state/provincial, tribal and local governments, businesses, conservation organizations and individuals in developing implementation plans that focus on areas of concern that have been identified in the plan.

Management efforts to date have focused on maintaining a mix of emergent marsh and open water with submergent vegetation and keeping populations of both aggressive native plant species such as cattail and non-native species such as *Phragmites*, purple loosestrife and Eurasian water milfoil in check. Non-native animals such as carp and mute swans are also a problem. The primary tool for maintaining open water consists of manipulating water levels to expose the beach ridges, cutting or burning the cattails and then reflooding the area. Complete drawdown is avoided because it appears to stimulate germination of purple loosestrife. Along the dikes, where *Phragmites* has invaded, cutting and water level manipulation are also used for control. Invasive species management is impeded somewhat by the fact that Rodeo, the aquatic form of glyphosate (Roundup) most commonly used in the United States has not been approved for use in Canada. Mute swans are managed by a combination of techniques including nest destruction, oiling eggs and removing adult birds under permit (personal communication, Gary McCullough, 2004).

Ojibway Prairie Complex

The Ojibway Prairie Complex is located on the outskirts of Windsor and is comprised of 5 separate units, totaling 834 acres (521 hectares), which are ecologically related and in close proximity to one another. The Windsor prairies, oak savannas and woodlands are remnants of the extensive wet prairies that historically lined the shores of the Detroit River and eastern Lake St. Clair. Present day communities range from wet and wet mesic prairie and woodlands to drier prairies and savanna. The site contains 110 provincially rare species, making it the floristically richest site in Ontario.

FACT

The Ojibway Nature Centre has undertaken mark and recapture studies of eastern massasauga and eastern fox snakes using radiotelemetry in the area.

The Ojibway Prairie Provincial Nature Reserve, occupying 230 acres (105 hectares), contains a mixture of tallgrass prairie and black oak savanna. It is managed by Ontario Parks and management activities include prescribed fire by the OMNR Fire Management Unit and control of invasive species such as black locust (Ross Hart, 2004, personal communication).

The City of Windsor owns and manages an additional three units: Ojibway Park, Tallgrass Prairie Heritage Park and Black Oaks Heritage Park, which total 315 acres (127 hectares). It is also in the process of acquiring private holdings within the fifth unit - the Spring Garden Life Science Area of Natural and Scientific Interest, with a combination of municipal and federal funds, through the Habitat Stewardship Program for Species at Risk. Life Science Areas of Natural and Scientific Interest (ANSI-LS) are privately owned sites that have been identified by the Ontario Ministry of Natural Resources as having provincially or regionally significant representative ecological features.

Endangered Species Recovery Fund

The Endangered Species Recovery Fund (ESRF) is a collaborative effort led by Environment Canada and WWF to save Canada's wildlife at risk.

The Endangered Species Recovery Fund (ESRF) sponsors high-priority conservation projects to assist the recovery and protection of endangered Canadian wildlife and their natural habitats. Currently, 456 Canadian species are listed as being "at risk" by the Committee on the Status of Endangered

Although nature related recreation is the primary focus of the municipally owned parcels, stewardship of

the land is a priority. Prescribed burning by local contractors is used to maintain prairie and woodland. A variety of volunteer stewardship activities are coordinated through the Nature Centre, including invasive species removal, native seed collection, plant propagation and restoration projects in the park and surrounding community. Many of these activities occur in cooperation with the Natural Habitat Restoration Program of the Essex County Field Naturalists. The Nature Centre also has undertaken studies of eastern massasauga and eastern fox snakes in the area. Funding for mark and recapture studies using radiotelemetry are funded through the Endangered Species Recovery Fund (Personal Communication, Paul Pratt, 2004).

HIGHLIGHT
St John's Marsh, St. Clair Flats and Algonac State Park ranked highest as Potential Conservation Areas for the Michigan portion of the project area.

Michigan

The largest holdings of undeveloped lands in the Michigan portion of the project area are held by the Michigan Department of Natural Resources (MDNR) and of these lands, St John's Marsh, St. Clair Flats and Algonac State Park ranked highest as Potential Conservation Areas for the Michigan portion of the project area (See Section VII. C. 3.). State Lands within the project area fall into two categories: State Parks and State Game Lands.

State Parks

Two State Parks lie within the project area; Algonac State Park and Wetzel State Park. State Parks are administered by the Recreation and Parks Bureau and both natural and cultural resources within the parks are managed by the State Park Stewardship Program (SPSP). The primary goals of the SPSP are to inventory all natural and cultural resources within the park system, to protect these resources, to restore and manage native ecosystems and to preserve the native species within them. Inventories have been completed for all of the State's Parks and detailed management plans have been developed for many of them, including Algonac State Park.

Algonac State Park lies just north of the city of Algonac along the St. Clair River, occupying about 1500 acres (607 hectares), with a half-mile of river frontage[11]. Although the park was established primarily to provide recreational facilities, it contains some of the best examples of lakeplain prairie and lakeplain oak opening (savanna) in the entire state, with at least 22 endangered, threatened or special concern species, including cerulean warbler, eastern fox snake and the only known population of Gattinger's gerardia in the entire state. The park contains a number of separate prairie and oak opening units, which were originally part of a complex that covered over 4,500 acres (1821 hectares)[12].

HIGHLIGHT
Algonac State Park contains some of the best examples of lakeplain prairie and lakeplain oak opening (savanna) in the entire state, with at least 22 endangered, threatened or special concern species.

In 2001, a detailed ten-year stewardship management plan was completed for the park, including a history of the sites ecosystems, site descriptions, plant and animal inventories, threats and recommended management activities[13]. Threats to the survival or reestablishment of the park's rare natural communities include disrupted hydrology, fire suppression, invasive species, inholdings by private landowners and surrounding development and potentially increased recreation pressure by park visitors.

Proposed management activities for the park include restoration of lakeplain prairie, lakeplain oak opening and Great Lakes marsh, monitoring, education, volunteer stewardship, research and inventory and funding. The plan includes short-term objectives for restoring lakeplain prairie, lakeplain oak opening and Great Lakes marsh and monitoring methods to measure the extent to which goals have been met. Priorities for the actual lakeplain restoration include

using prescribed fire to reduce the tree density to less than one tree per acre and the relative dominance of trees and shrubs such as native hawthorns, hazelnut, native dogwoods and prickly-ash to less than 15 percent cover. Current restoration activities will be discussed in greater detail below.

FACT

Historically, St. John's Marsh was dominated by lakeplain prairie, until it was drained for agriculture. When agricultural activities ceased, the hydrology in the area had been altered and the land reverted to marshlands.

Wetzel State Park is located in Harrison Township in Macomb County and is largely undeveloped, providing areas for hiking, hunting, snowmobiling and cross-country skiing[14]. Within its 900 acres (364 hectares), 120 acres (49 hectares) are slated for wetland restoration and an additional 300 acres (121 hectares) of old farm land will be restored as prairie (Ernie Kafcas, 2004, personal communication).

State Game Lands

The St. Clair Flats Game Area and the Chesterfield Mini-game Area both occur within the project area. Game areas are managed by the Wildlife Division of the Department of Natural Resources, in accordance with management plans developed by the Division's Natural Heritage Program. The Chesterfield Mini-game Area occupies about 110 acres of which two thirds are open lands. The St. Clair Flats Game Area is considerably larger and more extensive information follows.

CASE STUDY

Coastal Habitat Restoration

Restoration work presently underway in Algonac State Park and the St. Clair Flats provides an excellent example of the benefits of partnerships between state and federal agencies, nonprofit organizations such as Ducks Unlimited, the Nature Conservancy, Wildlife Habitat Council and Pheasants Forever, private landowners and businesses. A North American Wetlands Conservation Act (NWCA) grant to Ducks Unlimited was matched by funding from the multiple partners to protect and restore wetlands and adjacent habitat on public lands within the Lake St. Clair and western Lake Erie watersheds, including the Detroit River.

The broader project focused on protecting and restoring Great Lakes coastal marshes and their associated habitats along shoreline areas, expanding existing state and federal wildlife areas and restoring and enhancing small wetlands and associated uplands important for waterfowl production on private lands throughout the watershed. The project includes components within 10 counties in Michigan and Ohio. Funded activities included land acquisition, restoration of marsh and prairie habitats, invasive species control and management agreements with private landowners.

Within the project area, efforts are focused on Algonac State Park and St. Johns Marsh, within the St. Clair Flats Wildlife Area. The restoration sites are closely associated with remnant lakeplain prairie and lakeplain oak openings/savanna's. These areas comprise a complex landscape of wet prairies, forested wetlands, savanna-like uplands and marsh and provide important breeding and migration habitat for grassland birds, waterfowl and other migratory birds. Upland restoration and enhancement involves prescribed burning, mechanical and chemical plant control (woody and noxious) and planting of native prairie (cont.)

The St. Clair Flats State Game Area includes St. John's Marsh (2,300 acres / 931 hectares) and most of the Michigan portion of the St. Clair delta, including a large portion of Harsen's Island (7,971acres / 3,226 hectares) and most of Dickinson Island (3000 acres / 1214 hectares)[15].

Historically, St. John's Marsh was dominated by lakeplain prairie, until it was drained for agriculture. When agricultural activities ceased, the hydrology in the area had been altered and the land reverted to marshlands. Although the majority of the marsh is undiked, it is partially separated from the lake by roads and developed areas. Water levels in the undiked portion fluctuate with those of Lake St. Clair, but the marsh does not experience the wave action typical along undeveloped shorelines. In the northeast corner of St. John's Marsh, a series of dikes, ditches, water control structures and channels have been constructed to establish food plots and high quality nesting, brood and migration habitats. Approximately 12% of the marsh is diked. A little over a third of this area is managed for food production and is planted with a mix of annuals, big bluestem (a native grass) and crops such as corn and buckwheat. A comparable area is managed as a green tree reservoir, where wetland trees such as pin oak, swamp white oak and ash are flooded in fall to provide natural food and habitat for waterfowl such as wood ducks and

(cont.) grasses and forbs to provide nesting areas for waterfowl and other grassland-dependent migratory birds.

At the St. Johns Marsh Wildlife Area, MDNR is restoring 92 acres of natural plant communities. The new restoration site consists of 67 acres of shrubbed-in wet prairies and other wetland communities. The prairie will be restored primarily through mechanical and chemical removal of shrubs and young trees, planting of native prairie species and prescribed burning.

The MDNR will restore 184 acres at Algonac State Park. The new restoration sites are composed of 80 acres of heavily shrubbed-in wet prairies and 10 acres of young forest that was formerly open savanna. The grass and forb seed bank largely remains in most former prairie areas and large old oak trees still exist within the matrix of young trees and brush in the oak openings. Restoration of the gross vegetation structure is the major restoration step needed in these areas. Future enhancement may be needed in some areas to re-establish missing prairie species and the sites will be maintained with prescribed burning. The prairie areas (80 acres) will be restored primarily through mechanical removal of shrubs and young trees and prescribed burning. The oak openings (10 acres) will be restored by cutting and herbiciding young trees and brush and by follow-up prescribed burning to create a savanna structure.

The North American Wetlands Conservation Act

The North American Wetlands Conservation Act (NAWCA) of 1989 provides matching grants to organizations and individuals who engage in partnerships to implement wetland conservation projects in the United States, Canada and Mexico. The Act was passed in part, to provide funding for activities initiated under the North American Waterfowl Management Plan; projects must focus on long-term wetland acquisition, restoration and or enhancement and partners must provide at least a 50 percent match.

mallards. The remainder of the diked area consists of managed marsh (Personal communication, Ernie Kafcas, 2004). Lakeplain prairie is being restored in part of the undiked portion of the marsh and will be discussed below. Prescribed fire by MDNR Fire Officers from the Forest Management and Fire Management Division is used for both waterfowl habitat management and lakeplain prairie restoration.

Historically, Dickinson and Harsen's Island consisted primarily of Great Lakes marsh. Lakeplain prairies were found along the eastern edge of both islands and small patches of oak-hickory forest were found on the east side of Harsen's Island[16]. Aside from Dickinson Island, much of the of the area's presettlement character has been dramatically altered. Within Dickenson Island, about 15% of the marsh has been diked by the Army Corps of Engineers for used as a Confined Disposal Facility, to hold dredged materials from the shipping canal. The remainder of the island remains in a natural condition, although shallow areas which experience drawdown have been invaded by *Phragmites*, or giant reed (Personal communication, Ernie Kafcas, 2004). Although much of Harsen's Island has been developed for vacation homes and hunting facilities, small amounts of lakeplain prairie and oak forest and extensive marshes and remain, although about 1800 acres of the marsh has been diked.

The Huron Clinton Metro Park Authority manages 13 regional parks which cover almost 24,000 acres. Although their primary focus is recreation, the Authority is working with Michigan Natural Features Inventory to survey and evaluate the natural areas within the parks system. Field surveys are underway to inventory rare plant species and exemplary natural communities. The surveys will be used to develop a management strategy for the natural areas.

FACT

Metro Beach Metro Park is one of the top 10 birding sites in Michigan with a variety of birds during migration, including warblers, waterfowl and hummingbirds.

Metro Beach Metro Park, the only Metro Park within the project area, occupies 770 acres of which approximately 300 acres are in a natural state. The park contains both Great Lakes marsh and wetland hardwood forest. The park is one of the top 10 birding sites in Michigan and is host to a variety of birds during spring and fall migration, including warblers, waterfowl and hummingbirds. Rare birds that breed in the park include least bitterns (State Threatened) and Forster's terns (State Threatened). The eastern fox snake (State Threatened) is known to breed here also. Although an inventory and management plan have not yet been completed, the park has begun to use prescribed fire and a volunteer invasive species removal program has been initiated (Personal communication Julie Champion, Dave Moilanen, 2004).

Belle Isle Park in the City of Detroit is literally an island of habitat, in an extremely urbanized landscape. The island includes 200 acres (81 hectares) of wetland forest, about 50 acres (20 hectares) of submergent marsh in the island's inland lagoons and canals and rare species present include pumpkin ash (State Threatened), Sullivant's milkweed (State Threatened), Shumard oak (Species of Special Concern) and Blanding's turtle (Species of Special Concern). The island is managed by the Detroit Recreation Department, which has no staffing for natural areas management. Accordingly, natural areas management and restoration activities are performed sporadically on a contract basis and generally funded by grants. Threats to Belle Isle's natural communities include invasive species such as the emerald ash borer and Phragmites, as well as the excessive use of road salt. Aquatic invasives such as Eurasian water milfoil, however, are being successfully controlled and the island's wild celery beds are thriving.

CASE STUDY
Spring Stopover sites

Because of the region's importance for migratory birds, identifying spring stopover sites for waterfowl, shorebirds, wading birds, songbirds, colonial nesting birds and raptors has been identified as a priority goal by a number of organizations. Identifying and prioritizing these sites, however, first requires a rigorous list of quantifiable and valid attributes of high quality sites for each of these species groups.

Accordingly, the Nature Conservancy and Ducks Unlimited will be conducting a literature review, interviewing experts and developing such a list, which will be made available to managers and policy makers to assist them in site prioritization and management. The project is funded by the Coastal Program of the U. S. Fish and Wildlife Service (Personal communication, Robert Kavetsky, 2004).

Habitat restoration around the Blue Heron Lagoon, at the far eastern end of the island, is being funded by a Michigan Coastal Management Program grant from NOAA, which is part of the U.S. Department of Commerce. The site contains relict lakeplain prairie species and efforts will focus on protecting existing habitat, restoring additional prairie and oak opening and improving connections to the river. A variety of oaks and shrubs grown from seed collected on the island will be included in the plantings. The lagoon itself is utilized extensively by overwintering waterfowl, particularly canvasbacks and redheads. This project continues work initiated by the U.S. Fish and Wildlife Service's Coastal Program, which included shoreline plantings, plant inventory and the establishment of a native plant nursery in the Island's greenhouses.

VI. A. 3. Aquatic Habitats

There are several significant differences between restoring terrestrial habitat and aquatic habitats: all bottomlands are owned by the State or Province so land cannot be acquired; flows (of nutrients, toxins, etc.) coming onto the site from elsewhere can have a much greater impact in aquatic habitats than in terrestrial habitats and be correspondingly more difficult to control. In most cases, maintaining the quality of aquatic habitats is accomplished by regulating activities that might affect water quality and substrate condition such as dredging, filling, construction adjacent to waterways and the discharge of chemicals and/or waste products into lakes and rivers. Targeted enhancements, however, can increase breeding or foraging habitat in many cases, including the local projects profiled below.

Goose Bay Fish Habitat Enhancement – Ontario

The City of Windsor and the Essex Region Conservation Authority cooperated in a project that combined both shoreline stabilization and aquatic enhancements to improve fish spawning and refuge habitat in Goose Bay Park. The municipal park is located in Goose Bay, one of the last remaining sheltered embayments along the Canadian side of the Detroit River. The project will aid in delisting the impaired beneficial use "loss of fish and wildlife habitat".

HIGHLIGHT
Habitat improvements in Windsor's Goose Bay Park will aid in delisting the impaired beneficial use "loss of fish and wildlife habitat".

Restoration and rehabilitation work involved the protection of the shoreline using a combination of rip-rap and native plants. This work also included submerged enhancements to improve fish spawning and refuge

habitat. Submerged enhancements include groynes, rock apron and cobble stone. Using these methods, the embayment is protected from swift current regimes and wave actions. The work, costing $161,000 and completed in 2000, was funded by Environment Canada's Great Lakes Cleanup Fund and the City of Windsor[17].

Belle Isle/Detroit River Sturgeon Habitat Restoration, Monitoring and Education Project

Sturgeon habitat restoration on Belle Isle in the Detroit River is being implemented by the U.S. Geological Service's Great Lakes Science Center, Michigan Sea Grant and a consortium of federal, state, university, local and non-governmental agencies and organizations. The project consists of three related components: construction of three demonstration lake sturgeon spawning reefs, a monitoring program and a public information/education program. Historically, lake sturgeon were abundant in the connecting waters between Lake Huron and Lake St. Clair, but their populations in Michigan are estimated to be at about one percent of their former abundance.

HIGHLIGHT

The Detroit River sturgeon project will include three demonstration spawning reefs, a monitoring program and a public information/education component.

The project team has constructed three demonstration spawning reefs of the southeastern shore of Belle Isle in the upper Detroit River. The reefs are constructed of three different substrates: screened, "shot rock" limestone, 6-24 inches in diameter, free of all fines; 4-6 inch igneous cobble; and screened, 1-3 inch, coal cinders, which have been successfully used by spawning sturgeon elsewhere.

Data from lake sturgeon captured and released at the project site will supplement data on the overall Detroit River sturgeon population and spawning success at the project site will provide quantitative estimates for comparison with such data collected at two active coal-cinder sturgeon spawning sites in the St. Clair River. Also, it will provide quantitative data on the extent to which the three different substrates are used by spawning sturgeon.

Great Lakes Fishery Trust

The mission of the Great Lakes Fishery Trust (GLFT) is to provide funding to enhance, protect and rehabilitate the Great Lakes fishery. The GLFT provides funding to educational institutions, non-profit organizations and government agencies for projects related to Great Lake fisheries for public education, research on the Great Lakes fishery, with special emphasis on rehabilitation of lake sturgeon and lake trout, fishery habitat protection and restoration and increased fishing access.

Major funding from the project came from the Michigan Coastal Management Program and the Great Lakes Fishery Trust, with in-kind services provided by the University of Michigan, Michigan State University, the U.S. Geological Survey, the U.S. Army Corps of Engineers-Detroit District, the Michigan Department of Natural Resources, DTE Energy, a regional gas and electric utility, the Greater Detroit American Heritage River Initiative of the Metropolitan Affairs Coalition and others.

VI. A. 4. Land Acquisition

Whenever possible, it is generally most cost effective to conserve resources and habitat in existing natural areas, rather than restoring or creating habitat on lands which have been already cleared. There are a number of programs intended to conserve lands, natural resources and healthy ecosystem function within the project area and often the simplest approach is simply to remove land from the potential pool of lands to be developed. This may occur in a number of ways: through outright purchase, acquisition of a conservation easement, or by agreements which limit the uses of a given piece of land for a specified period of time.

A major source of funding for public lands acquisition in Michigan is the Michigan Natural Resources Trust Fund (MNRTF). The Fund, using revenues from the development of State-owned mineral resources, provides funding to the Department of Natural Resources (MDNR) and local governments to acquire lands for natural resources and open space protection and outdoor recreation. Since no more than 25 percent of the available revenues can be used for devel-

HIGHLIGHT

The support of non-profit groups is critical for raising private donations and in the many additional aspects of habitat acquisition.

opment, the majority is designated for land acquisition projects. Only MDNR and local governments can apply to the MNRTF for assistance in acquiring property, individuals; groups and organizations may nominate specific land parcels for consideration[18].

In Ontario, some funding for wetland acquisition is available from the Eastern Habitat Joint Venture (EHJV), a regional partnership formed to implement provisions of the North American Waterfowl Management Plan. (See description on p. 153) In Ontario, EHJV partners include the Ontario Ministry of Natural Resources, the Canadian Wildlife Service, Ducks Unlimited Canada, Wildlife Habitat Canada, Ontario Ministry of Agriculture, Food and Rural Affairs, Nature Conservancy of Canada and Agriculture and Agri-Food Canada[19]. The Habitat Stewardship Program (HSP) for Species at Risk, which is administered jointly by Environment Canada, Parks Canada and Fisheries and Oceans Canada, provides funding to secure important habitat as part of its mandate. Recent additions to the Ojibway Prairie Complex were funded by the HSP, with matching funds from the City of Windsor (Personal communication, Paul Pratt, 2004).

Finally, the support of non-profit groups is critical, both in raising private donations and in multiple aspects of habitat acquisition. Often, non-profit organizations such as the Nature Conservancy/Nature Conservancy of Canada, Ducks Unlimited/Ducks Unlimited of Canada or the Trust for Public Land can facilitate the purchase of lands that are sometimes turned over to public agencies, using both public and private funding. Just south of the project area, for example, the Trust for Public Land paid $4.8 million to obtain Humbug Marsh, on the lower Detroit River. The Trust will eventually be repaid with a combination of federal monies, grants and donations and Humbug ownership will be turned over to the Detroit River International Wildlife Refuge[20].

VI. A. 5. Conservancies

There are a number of land trusts and conservancies operating within the project area, ranging from national organizations such as The Nature Conservancy/Nature Conservancy of Canada, to regional groups such as the Michigan Nature Association or Canada South Land Trust to groups which restrict their efforts to a single county such as Macomb Land Conservancy or Lambton Wildlife Inc. Land conservancies and land trusts can purchase land for resale to public agencies, buy options to protect land temporarily, receive land donations, put together land deals and provide technical assistance. As private entities, they can often act more quickly and cost-effectively than public agencies.

HIGHLIGHT

As private entities, land conservancies and land trusts can often act more quickly and cost-effectively than public agencies.

In addition, many conservancies and land trust make extensive use of conservation easements to protect private held lands. Conservation easements are a legal agreement between a landowner and a conservancy or government agency that permanently limit the uses of the land in order to protect specific characteristics of the land. Conservation easements offer great flexibility; they may prohibit any development or may permit some specified uses[21].

In Michigan, many landowners receive a federal income tax deduction for the gift of a Conservation Easement. The Internal Revenue Service allows a deduction if the easement is perpetual and donated "exclusively for conservation purposes." The amount of the tax deduction is determined by the value of the conservation easement. In addition, the donor may have estate and property tax relief[22].

In Ontario, under the provisions of the Income Tax Act (Canada), the Ecological Gifts Program provides favorable income tax treatment to donors of ecologically sensitive lands (ecogifts), including conservation easements. Donated land or easements must be certified by Environment Canada staff, who will provide certification for inclusion with the donor's income tax return[23].

Michigan

The **Macomb Land Conservancy** (*www.savingplaces.org/contact.html*) was founded in 2000, by a group of concerned citizens working to preserve a 63-acre parcel of mature upland and swamp forest along Coon Creek, in Ray Township. Their mission includes identifying and preserving significant natural areas and habitat, supporting the preservation of farmland and the agricultural economy of Macomb County, assisting local communities to plan for growth and development and conducting public education programs that encourage residents and communities to become stewards of public and private land. The Macomb Land Conservancy uses conservation easements and donations of land to meet these objectives.

Incorporated in 1988, the **Southeast Michigan Land Conservancy** (*www.bendor.org/smlc.html*) is dedicated to the preservation and stewardship of natural and agricultural land in the seven county of southeast Michigan. They operate in Livingston, Macomb, Monroe, Oakland, St. Clair, Washtenaw and Wayne Counties and have preserved over 1,500 acres through 24 projects, including eight nature preserves, eight conservation easements through cooperative efforts with private owners and ten land donations. They focus on open spaces close to home and their activities also include participation in coalition efforts to coordinate land use policy, protect open space, preserve scenic beauty and defend watersheds from harmful development and pollution.

The **Michigan Nature Association** (MNA) (*www.michigannature.org*) is the state's first land preservation organization and has protected Michigan's rare native species and unique natural habitats for over 50 years. MNA currently protects over 8,000 acres statewide in 160 different nature sanctuaries which they own and manage. Their 70 acre Shadbush Tract Nature Study Area lies along the Clinton River in Macomb County and contains more than 50 species of trees and shrubs. They utilize volunteer stewards to maintain trail, control invasive weeds and lead field trips.

Founded in 1951, **The Nature Conservancy** (TNC) (*http://nature.org*) works to protect the state's finest wetlands, forest, shoreline and prairies through purchase, partnership or donations. It has protected 83,856 acres of critical lands statewide. The Conservancy protects habitat through gifts, exchanges, conservation easements, purchases, as well as management agreements and partnerships with large private and public landowners to protect the important natural features of their land. Although TNC does not own preserves within the project area, their science-based ecoregional planning process has identified Algonac State Park, St. Clair Flats and Metro Beach Metro Park as Conservation Priorities – sites of global ecological significance. They have played a major role in the establishment of the Southeast Michigan Stewardship Network (See Section VI. A. 8.).

Ontario

The **Canada South Land Trust** (*http://canadasouthlandtrust.org*) is the newest of the land trusts operating in the project area: it was registered as a conservation charity with Environment Canada in May, 2003 and emphasizes the preservation of natural heritage within the County of Essex, the City of Windsor, Pelee Island and the Municipality of Chatham-Kent. A grant from the Ontario Trillium Foundation is funding a "Resource and Strategy Guide" for the land trust which will guide the organization's activities over the next five years. The guide will show the natural areas, core areas and corridors and where restoration could significantly enhance these areas in Essex County and the Municipality of Chatham- Kent. This document would suggest areas where the Canada South Land Trust might focus, providing strategies the land trust might take to protect and preserve natural habitat, especially in areas where other conservation groups are not working or would not work to protect natural habitat.

Lambton Wildlife Inc. (LWI) (*www.lambtonwildlife.com*) is a nonprofit, volunteer, naturalist organization, founded in 1966 and is licensed as a charitable corporation under the Income Tax Act. They are dedicated to the conservation, preservation and protection of the natural environment in Lambton County. LWI owns and/or manages several environmentally important or unique properties in Lambton County including Mandaumin Woods, the Port Franks Forested Dunes, the Karner Blue Sanctuary and the Howard Watson Nature Trail. In addition LWI was instrumental in the establishment of the Ausable Valley Trail, the creation of the Wawanosh Wetlands, the purchase of the Mystery Falls property near Arkona and the establishment of Centennial Park.

The **Nature Conservancy of Canada** (NCC) (*www.natureconservancy.ca*) has been working for over 40 years, to protect Canada's most threatened natural habitats and the endangered species that call them home. In 1998 they identified the Carolinian zone, or southern Ontario, as a priority area for action in securing habitat. Among their recent acquisitions is a rare 762-acre forest, Bickford Oak Woods - the largest private woodland in Lambton County and the largest Clay Plain forest in the Carolinian Zone, outside of First Nations land. NCC is Canada's only national charity dedicated to preserving ecologically significant areas through outright purchase, donations and conservation easements.

VI. A. 6. Watershed-based Organizations

Effective stewardship efforts recognize that rivers and lakes defy political boundaries. Anchor Bay and the Clinton, St. Clair, Sydenham and Thames Rivers drain directly into Lake St. Clair; its watershed encompasses approximately 3,927,175 acres (1,589,270 hectares) in Michigan and Ontario, partially or wholly draining 14 counties and numerous municipalities. There are a variety of watershed-based organizations involved in protecting these streams, rivers and ultimately Lake St. Clair. In some cases, they are nonprofit citizen-based advocacy groups, drawing resources from a mix of private and grant funds and relying heavily on volunteer efforts. In other cases, they consist of working partnerships of stakeholders and political entities or governmental agencies charged with protecting resources under international treaty.

HIGHLIGHT

In Ontario, under the federal Accord for the Protection of Species at Risk, Recovery Plans must be prepared for nationally endangered and threatened species.

In Ontario, under the federal Accord for the Protection of Species at Risk, Recovery Plans must be prepared for nationally endangered and threatened species. The Plans are prepared by a Recovery Team and include a recovery strategy and a coordinated action plan. An ecosystem approach to recovery planning for aquatic species was pioneered within the project area in the Sydenham River Recovery Plan and was followed by the Thames River Recovery Plan[24].

Some sorts of watershed groups are limited to either Michigan or Ontario. In Michigan, in response to requirements of the Michigan Department of Environmental Quality Phase II Watershed-based Storm Water Permit process (See Section V. A. 2.), a number of communities have cooperated to form subwatershed advisory groups. In Ontario, the Regional Conservation Authorities tend to be organized by watershed and are active in multiple habitat, drainage and water quality issues. Increasingly, these diverse groups are working together, to leverage resources and support common goals.

St. Clair River

Although technically not a watershed-based initiative, work under the St. Clair River Remedial Action Plan Process to clean up the St. Clair River Area of Concern has involved activities at the watershed-scale. The St. Clair River Remedial Action Plan Habitat Sub-Committee and the St. Clair River Binational Public Advisory Council commissioned two studies relating specifically to habitat concerns within the watershed: *A Natural Heritage System for the St. Clair River Watershed* (*www.friendsofstclair.ca/pdf/nhs.pdf*) and *The St. Clair River Area of Concern: Binational Habitat Management*

CASE STUDY
MacDonald Park Restoration

A wetland and prairie restoration project was carried out in MacDonald Park on the *Chenal Ecarte* along the St. Clair River through the St. Clair River Remedial Action Plan (RAP) process in order to help restore fish and wildlife habitat in the St. Clair River watershed. This particular site was chosen due to its high potential for a variety of aquatic and upland restoration techniques, the visibility and accessibility along a commonly traveled roadway, and the strong interest of the landowner (St. Clair Parkway Commission). The project involved the creation of 1 ha (2.5 acres) of wetland, 1 ha (2.5 acres) of Tallgrass Prairie complete with an interpretive trail, improvement of 200 m (219 yards) of shoreline riparian area, and interpretive signs and brochures.

The wetland component included a variety of wildlife and fisheries components; spawning mounds, submerged habitat structures, aquatic vegetation plantings, and basking logs. Shoreline areas were reshaped, gently sloped, and stabilized using live willow stakes and brush bundles to establish riparian cover and as a means to reduce erosion. Planting of aquatic vegetation in the nearshore waters adjacent to these areas occurred in a subsequent phase. Experimental biolog floating barriers and bogmat islands were installed to establish in-water structure and provide erosion protection to local shoreline areas.

In the 1 ha (2.5 acres) upland site, 22,000 Tallgrass Prairie plugs of 23 different forb (flower) and grass species were planted. A slightly elevated horseshoe shaped trail system was constructed using excavated material from the wetland area to allow trail users an improved view of the prairie plant species, at the height of their growing season[25].

Plan (*www.friendsofstclair.ca/pdf/hab_mgmt_plan.pdf*) that address a broad range of habitat related issues and options for increasing ecological integrity.

The **Friends of the St. Clair River** (*www.friendsofstclair.ca*) is an all-volunteer registered Canadian charitable organization, whose purpose is to promote conservation, beautification and other environmental activities associated with the St. Clair River and assist in the development and implementation of the St. Clair River Remedial Action Plan (RAP). Their membership consists of approximately 30 people who are the Canadian members of the St. Clair River Binational Public Advisory Committee (BPAC). Their website posts information relating to the RAP, including meeting minutes and the documents noted above.

Clinton River

The **Clinton River Watershed Council** (CRWC) (*www.crwc.org*) is a non-regulatory, non-governmental environmental education organization, whose mission is to protect, enhance and celebrate the Clinton River, its watershed and Lake St. Clair. The Clinton River drains 760 square miles in Macomb, Oakland, St. Clair and Lapeer Counties and its watershed includes over 1,000 miles of streams in addition to the 80-mile-long main branch. The Council was established initially in 1972 as a communication forum to coordinate local governments' efforts to protect and improve the river basin and in 1994, the council reorganized to become a 501(c)3 nonprofit organization. This allowed additional revenue to come from grants, businesses and individual membership contributions.

Today, CRWC organizes stewardship efforts, such as River Day, Adopt-A-Stream and Clinton Clean-Up and provides education and watershed management programs for local governments, organizations, businesses and individuals. They provide programs and workshops to hundreds of individuals, groups, businesses and local governments each year on water quality and land management issues and also offer one-on-one technical assistance, including site visits, plan reviews and permit application reviews.

CASE STUDY
Adopt-a-Stream

The Clinton River Watershed Council Adopt-a-Stream is a volunteer-based program that empowers community members to protect local streams and rivers by monitoring their health. Volunteers are teamed up in Stream Teams, are assigned sites, given equipment, data sheets and protocols, and are sent out to gather information on streamside habitat and macroinvertebrate populations.

Twice a year (in May and October), Stream Teams visit their adopted sites and collect data, including physical and chemical information. They collect and identify macroinvertebrates that live in the streambed and surrounding vegetation. A stream's health can be determined by the number and types of bugs that (cont.)

Detroit River

Efforts to restore the Detroit River Area of Concern have engendered the establishment of several organizations, including the **Detroit River Canadian Cleanup Committee** (DRCCC) or **Canadian Public Advisory Council** (*www.drccc.info*), the **Detroit River Remedial Action Team** (*www.msue.msu.edu/wayne/detroitriver.html*), and the **Friends of the Detroit River** (*www.*

(cont.) live in it. The data are used by CRWC, municipalities and the state to assess the health of our streams and rivers and make decisions regarding their protection and restoration.

Citizen involvement in water quality monitoring activities has resulted in positive change across the nation, the state, and right here in the Clinton River watershed. For example, water quality data collected by volunteers for the Clinton River Coldwater Conservation Project has been used to select locations for trout habitat restoration, and students in our Stream Leaders program have helped identify and resolve soil erosion problems.

detroitriver.org) which is working in support of the Detroit River International Wildlife Refuge and is in the process of identifying remaining significant habitat along the river for protection and possible acquisition.

Thames River

The **Thames River Recovery Plan** (*www.thamesriver.org/Species_at_Risk/species_at_risk.htm*) was initiated under the mandate of both federal and provincial governments and the Upper and Lower Thames Conservation Authorities are taking a significant role[26]. A Recovery Team has been assembled to prepare an Ecosystem Recovery Strategy for aquatic species at risk within the river. Several species that live in the Thames are found almost nowhere else in Canada, but their numbers are shrinking as a result of development pressure; a number of species which were historically present have not been sighted in many years. Twenty-four aquatic species found in the Thames River have been nationally listed as extirpated, endangered, threatened, or of special concern[27].

FACT

Several species that live in the Thames are found almost nowhere else in Canada, but their numbers are shrinking as a result of development pressure.

The team, comprised of experts, stakeholders and governmental representatives will prepare a recovery strategy – a science-based document that identifies the goals, objectives and approaches for recovery. They then will prepare one or more recovery action plans, which outline the specific actions needed to achieve the goals of the strategy[28]. Actions will include activities such as raising awareness about the diversity of species, involving the community in species recovery and improving aquatic habitat and monitoring for changes in species populations[29].

Sydenham River

The **Sydenham River Recovery Plan** was initiated in 1999 and its Recovery Strategy, completed in 2003, was the first to utilize an ecosystem approach for aquatic species[30]. Members of the Recovery team took this approach for a number of reasons: 14 species designated at risk occur in the river; threats to species at risk and their habitat appeared to be directly related to land use throughout the entire watershed; and a multi-species approach was more efficient than implementing a series of single-species plans, allowing stakeholders to participate in a single planning exercise rather than separate exercises for each species.

HIGHLIGHT

The Sydenham River Recovery Plan was initiated in 1999 and its Recovery Strategy was the first to utilize an ecosystem approach for aquatic species.

In preparation for recovery planning, the Sydenham team synthesized existing information on four key elements deemed essential to understanding the watershed and its associated aquatic species: species at risk, land use, water quality and stream channel structure. The synthesis provided the team with an overview of the health of the river's ecosystem and its major anthropogenic stresses, allowing the development of the recovery strategy. While the strategy takes a broad view of the watershed, it retains its focus on individual species and examines factors that might benefit one species at the expense of another. Long-term monitoring and ongoing research will improve knowledge of the watershed, its species at risk and how the system responds to recovery actions. New information will be integrated into the next revision of the recovery strategy, which is updated on a five-year cycle[31].

Michigan

In response to the Phase 2 Stormwater Program (see section VI. C. 3.), the municipalities that lie within the subwatersheds on the Michigan side of Lake St. Clair have cooperated in the formation of Subwatershed Advisory Groups, in order to develop Stormwater Management Plans. Within the Clinton River watershed, groups include the **Upper Clinton/Headwaters** (*www.crwc.org/programs/phase2/Subwatersheds/upperclinton.html*), **Stony Creek/Paint Creek, Clinton/Main, North Branch, Clinton River East** (*www.crwc.org/programs/phase2/Subwatersheds/crew.html*) and **Red Run** (*www.crwc.org/programs/phase2/Subwatersheds/redrun.html*) **Subwatershed Advisory Groups**. Additional groups in the area include the **Lake St. Clair Direct Drainage** (*www.crwc.org/programs/phase2/Subwatersheds/LSC.html*) and **Anchor Bay Direct Drainage Subwatershed Advisory Groups**. Their potential impact on habitat quality is twofold; by planning for responsible stormwater planning they can eliminate sources of environmental degradation such as non-point source pollution, erosion and sedimentation and also, many of the methods that can be utilized (vegetative swales, buffer strips, wetland creation) create additional habitat.

HIGHLIGHT

Responsible stormwater planning can eliminate sources of environmental degradation such as non-point source pollution, erosion and sedimentation and many of the methods that can be utilized such as vegetative swales, buffer strips, and wetlands provide additional habitat.

The **Macomb-St. Clair Inter-county Watershed Management Advisory Group** is comprised of representatives of the Macomb and St. Clair County Water Quality Boards. These citizen-led boards were authorized by their respective County Boards of Commissioners to coordinate county water quality programs, collect and respond to citizen concerns and advocate for water quality improvements.

In their combined role within the Macomb-St. Clair Inter-county Watershed Management Advisory Group, they have not been delegated any formal authority by either county's Board of Commissioners but work on a consensus basis with an emphasis on sharing information with local decision makers. Some of the group's specific initiatives have included support for development of a watershed management plan for the Anchor Bay portion of Lake St. Clair and development of a monitoring inventory and strategic plan for the U.S. portion of Lake St. Clair[32].

Ontario

In Ontario, there are three regional Conservation Authorities which engage in a wide range of activities (See Section II. A. 2.). Conservation Authorities were created in 1946 by an act of the Provincial Legislature and initially focused on flood and erosion control. Their role has evolved considerably and they are mandated to ensure the conservation, restoration and responsible management of Ontario's water, land and natural habitats through a broad range of programs that balance human, environmental and economic needs. Public lands which were initially acquired in connection with flood control initiatives are now used extensively for recreation and provide valuable wildlife habitat as well in many cases[33].

Conservation Authorities have the authority to implement regulations for filling and construction within floodplains and to regulate construction within the waterway. Their staffs provide technical assistance and plan review services for landowners and developers and also cooperate with other governmental entities to assure consistency in watershed related issues in official plans, zoning bylaws, etc.

The **St. Clair Region Conservation Authority** (SCRCA) (*www.scrca.on.ca/AboutUs.htm*) is located in southwestern Ontario and includes the Sydenham River watershed and thirteen smaller watersheds draining directly into southern Lake Huron, the St. Clair River and northeastern Lake St. Clair. Recent habitat-related projects have included wetland restoration, bioengineering and reforestation initiatives. The St. Clair Region Conservation Authority owns or oper-

ates 15 Conservation Areas and 6 Habitat Management Areas. Their Conservation Areas include wetlands, forests and urban parks.

The **Lower Thames Valley Conservation Authority** (LTVCA) (*www.lowerthames-conservation.on.ca*) has jurisdiction over the watersheds of all streams which drain into the Thames River from the village of Delaware to Lake St. Clair. The Authority has encouraged the planting of trees for windbreaks, small woodlots and wildlife shelter. Since 1985, over 1.5 million trees have been planted in the watershed. LTVCA owns and manages over 1,000 acres of conservation land at 20 sites for public use across its watershed.

The **Essex Region Conservation Authority** (ERCA) (*www.erca.org*) owns or manages 12 publicly accessible properties throughout the Essex region. The areas, totaling over 1000 hectares, protect some of the most important woodlands, marshes and shoreline areas in the region. Two of those directly border Lake St. Clair: Ruscom Shores Conservation Area and Tremblay Beach Conservation Area. Natural habitats within the Conservation Areas are actively managed for the maintenance and enhancement of biodiversity through the use of prescribed burns, drawdown and water level manipulation in wetlands and native plantings to create additional habitat.

VI. A. 7. Programs for Private Landowners

Michigan

Ducks Unlimited (DU) (*www.ducks.org*) conserves, restores, and manages wetlands and associated habitats for North America's waterfowl. These habitats also benefit other wildlife and people. Ducks Unlimited biologists combine administrative and biological expertise in the planning and delivery of on-the-ground habitat restoration projects.

HIGHLIGHT

Ducks Unlimited biologists combine administrative and biological expertise in the planning and delivery of on-the-ground habitat restoration projects.

Providing technical assistance to private landowners; incorporating wildlife ecology into habitat-based project design, and providing wetland restoration management services are just some of the skills and services offered by DU biologists[34]. For additional information on DU's work within the project area, see the case study describing the Lake St. Clair/Western Lake Erie Watershed Project in Section VI. A. 2.

The **Landowner Incentive Program** (LIP) was developed by the Michigan Department of Natural Resources' Wildlife Division to assist private landowners and non-profit organizations in enhancing, restoring and protecting wetland and grassland habitats on their lands. They provide advice, technical assistance, management plans and financial assistance for conducting prescribed burns on grasslands and wetlands, managing to remove exotic/invasive species and restoring remnant prairies, savannas and wetlands. Within the project area, only portions of St. Clair County have been designated as priority areas, but they are also willing to consider large parcels of suitable habitat in other counties[35].

The U.S. Fish and Wildlife Service's **Partners for Fish and Wildlife Program** (*http://partners.fws.gov/pdfs/PFW04actsheet4.pdf*) is a partnership program that helps private landowners restore wetlands and other important fish and wildlife habitat on their own lands by providing financial and technical assistance through voluntary cooperative agreements. Typical partners include the Natural Resource Conservation Service, Michigan Department of Natural Resources and Ducks Unlimited. The program focuses on improving habitat for migratory birds and federally listed species. In Michigan, wetland restoration has been a primary goal, but grassland, stream channel and riparian corridor restorations are increasing[36].

The **Forest Land Enhancement Program** (FLEP) (*www.midnr.com/Publications/pdfs/ForestsLandWater/ForestStewardship/FLEPfactsheet.pdf*) is authorized under the U.S. Farm Security and Rural Investment Act of 2002, popularly known as the 2002 Farm Bill and is administered the Michigan Department of Natural Resources to encourage

wise management of non-industrial private forests. The program offers cost-share for management plan development, reforestation, forest stand improvement, water quality improvement and watershed protection, fish and wildlife habitat improvement, forest health and protection, invasive species control and wildfire and catastrophic event rehabilitation.

The **2002 Farm Bill** offers a number of additional conservation programs through the Natural Resources Conservation Service (NRCS), the Farm Service Agency, USDA Service Centers and County Conservation Districts to provide incentives to farm owners to engage in a wide variety of stewardship activities and several are described below:

CASE STUDY
Lakeplain Prairie Restoration and the Conservation Reserve Program

In Michigan, CRP has a specific program to restore lakeplain wet prairie because of the rarity of this natural community within the state and its value as habitat for a variety of wildlife, particularly waterfowl, upland gamebirds and songbirds. To be eligible for this practice, the lands must be within a half mile of lands that were identified as lakeplain prairie on the state's presettlement vegetation maps. Lands must be planted with at least 5 native grasses or sedges, at least 10 native wildflower species and the hydrology of the site must be restored. The program also includes a management requirement for activities such as burning, light discing, interseeding of wildflowers, etc. according to a prescribed management plan[37].

The **Conservation Reserve Program** (CRP) (*www.fsa.usda.gov/dafp/cepd/crp.htm*) is a voluntary program for agricultural landowners. CRP offers annual rental payments and cost-share assistance of up to 50 percent to establish long-term, resource conserving covers on eligible farmland. CRP is designed to protect topsoil from erosion, safeguarding groundwater and improving the condition of lakes, ponds and streams. Offers for CRP contracts are ranked for consideration on the basis of their anticipated wildlife habitat and water quality benefits as well as a number of other criteria.

The **Grassland Reserve Program** (EQIP) (*www.nrcs.usda.gov/programs/GRP*) is a voluntary program offering landowners the opportunity to protect, restore and enhance grasslands on their property. The Natural Resources Conservation Service, Farm Service Agency and Forest Service are coordinating implementation of GRP, which helps landowners restore and protect grassland, rangeland, pastureland, shrubland and certain other lands and provides assistance for rehabilitating grasslands. The program will conserve vulnerable grasslands from conversion to cropland or other uses and conserve valuable grasslands by helping maintain viable ranching operations.

The **Wetlands Reserve Program** (WRP) (*www.nrcs.usda.gov/programs/wrp*) is a voluntary program offering landowners the opportunity to protect, restore and enhance wetlands on their property. The USDA Natural Resources Conservation Service (NRCS) provides technical and financial support to help landowners with their wetland restoration efforts. The NRCS goal is to achieve the greatest wetland functions and values, along with optimum wildlife habitat, on every acre enrolled in the program. This program offers landowners an opportunity to establish long-term conservation and wildlife practices and protection.

The **Wildlife Habitat Incentives Program** (WHIP) (*www.nrcs.usda.gov/programs/whip*) is a voluntary program for people who want to develop and improve wildlife habitat primarily on private land. Through WHIP USDA's Natural Resources Conservation Service provides both technical assistance and up to 75 percent cost-share assistance to establish and improve fish and wildlife habitat. WHIP agreements between NRCS and the participant generally last from 5 to 10 years from the date the agreement is signed.

Ontario

Ducks Unlimited Canada (DUC) (*www.ducks.ca*) has been committed to wetland conservation for more than 65 years. Like Duck Unlimited in the U.S, DUC conserves, restores, and manages wetlands and associated habitats for North America's waterfowl. Despite this, wetland loss continues across Canada. As much as 70 per cent of Canada's original wetlands have been lost in some areas of the country.

DUC's conservation efforts take many forms. On-the-ground work is guided by the wetland and environmental research of DUC's scientists. DUC works to change policy in favour of wetland and habitat conservation. DUC also

delivers wetland and environmental education programs to teach Canadians about wetlands and the need to conserve them.

The **Regional Conservation Authorities**, which were discussed in the previous section (See Section VI. A. 6.) provide information and technical assistance on subject ranging from habitat restoration, native plants, development of naturalized ponds to invasive species control and may also provide information on potential funding resources.

The Ontario Ministry of Natural Resources initiated **Ontario Stewardship** (*www.ontariostewardship.org*), a program comprised of community stewardship councils, to link landowners, land interest groups and agencies to encourage responsible land care on private lands. Three of these operate within the project area:

The **Rural Lambton Stewardship Network** (RLSN) (*www.ontariostewardship.org/LAMBTON/lambton.htm*) is a grassroots communication and partnership organization dedicated to the care of Lambton County's varied natural resources. Begun in 1994 as one of the pilot projects for the Private Land Stewardship Project, the RLSN has been involved in numerous comprehensive, multi-partner, stewardship projects. The focus of these projects is habitat restoration, conservation and enhancement. Projects have included making no-till equipment available to farmers for testing, transfer and adaptation of prairie rehabilitation and restoration technologies, establishment of a self-sustaining nursery to produce a source for indigenous seed to restore tallgrass prairie in Ontario and reintroducing and managing a population of northern bobwhite quail.

Stewardship Kent (*www.ontariostewardship.org/KENT/kent.htm*) exists to provide rural landowners in Chatham-Kent with the tools to achieve natural resource management objectives, which contribute to sustainable agriculture and a healthy landscape for fish, wildlife and forestry. Stewardship Kent is partnering with a number of other organizations in the Sydenham River Stewardship Initiative to provide landowners along the river with funding for a variety of project intended to improve habitat value and overall water quality.

The **Essex County Stewardship Network** (*www.ontariostewardship.org/Essex/essex.htm*) is working to sustain and improve the remaining natural features of the county, while at the same time assisting landowners to achieve their land management objectives. Supporting productive farming practices while incorporating enhancements and protection for the area's natural resources is the network's main directive. Recent projects have included the development of a "Landscape Strategy for the Wetlands of the Western Basin of Lake Erie", a Crown Land Demonstration Farm and a tree planter loan program.

VI. A. 8. Training, Technical Assistance and Additional Resources for Public and Private Habitat Projects

Michigan

The **Michigan Stewardship Network** (*www.snre.umich.edu/stewardshipnetwork*) is a partnership of groups and individuals in the area working to foster land and water stewardship, dedicated to preserving and restoring natural areas in southeast Michigan. They provide networking opportunities through Steward's Circles -- regular informal gatherings of volunteer and professional land stewards that focus on particular topics of interest such as managing invasive species, seed collection, prescribed fire, herbicide and managing volunteers.

HIGHLIGHT

The Michigan Stewardship Network offers periodic training workshops on effective natural areas management techniques for restoring an area's native biodiversity.

The Stewardship Network also offers periodic training workshops on effective natural areas management techniques for restoring an area's native biodiversity. Courses combine classroom sessions with hands-on experience in the field.

USDA's **Natural Resource Conservation Center** (NRCS) (*www.nrcs.usda.gov*) provides leadership in a partnership effort to help people conserve, maintain and improve natural resources and the environment. NRCS provides technical expertise and assistance on topics that range from soil bioengineering techniques and conservation buffers to backyard habitat creation. Their Resource Conservation and Development program focuses on improvement of quality of life achieved through natural resources conservation and community development. NRCS can provide grants for land conservation, water management and environmental needs in designated RC&D areas.

The **St. Clair Conservation District** (*www.cis.stclaircounty.org/government0029.asp*) is a "unique" local unit of State Government that utilizes state, federal and private sector resources to solve today's conservation problems. The guiding philosophy of all Conservation Districts is that decisions on conservation issues should be made at the local level, by local people, with technical assistance provided by government. Created to serve as a steward of natural resources, the St. Clair Conservation District takes an ecosystem approach to conservation and protection, playing a role in urban and non-urban areas where land use change is taking place.

The **Macomb Conservation District** (*www.macombcd.com*) operates under the Soil Conservation District Law and its mission is to ensure that land, water, forest and wildlife and all natural resources of the county are managed for sustained use for future generations. They provide of information for farmers, coordinating federal, state and local technical. They also have begun a Macomb Buffer Initiative designed to improve water quality in Macomb County by installing urban conservation buffers. They are funded in part by the proceeds of annual tree and native plant sales.

The **Wayne Conservation District** (WCD) (*www.waynecd.org*) is a local agency of state government assisting landowners and residents with the conservation and management of our county's natural resources. The Wayne CD was formed in 1969 to assist the USDA with organization and distribution of the county soil survey. Since, the CD has expanded to address conservation issues relating to soil, water, air, plants and wildlife, in rural, suburban and urban Wayne County.

VI. B. Inventory and Monitoring Tools

Monitoring and inventory efforts which provide valuable information for conservation planning and restoration. There are a number of different organizations that engage in environmental monitoring within the Lake St. Clair watershed; programs range from volunteer sampling of stream invertebrates to local health departments' test results for Escherichia coli levels on public beaches to the U.S. Environmental Protection Agency's Toxic Release Inventory. Several key monitoring and inventory tools for Lake St. Clair are discussed below.

VI. B. 1. Lake St. Clair Monitoring Inventory

In order to meet the increasing need for coordination, collaboration and prioritization among monitoring agencies, the Great Lakes Commission, at the initiation of the U.S. Army Corps of Engineers - Detroit District, developed a Lake St. Clair Monitoring Inventory with the cooperation of a number of other federal, state/provincial and local organizations. Efforts were directed primarily at creating a comprehensive inventory of U.S. monitoring programs, although some program information regarding Canadian monitoring programs was included. In conjunction with the inventory, the Commission also performed a gap analysis to identify critical gaps in existing monitoring programs and then incorporated the results of this analysis into the Lake St. Clair Monitoring Strategic Plan, which examines opportunities to better coordinate monitoring programs to meet previously identified needs.

HIGHLIGHT

The Lake St. Clair Monitoring Inventory is a web-based, searchable database containing descriptive information on over 90 environmental monitoring programs in the area.

Monitoring Inventory

The Lake St. Clair Monitoring Inventory is a web-based, searchable database containing descriptive information on over 90 environmental monitoring programs in the area. The searchable database contains a variety of descriptive characteristics, including, but not limited to contact information, program description, parameters, geographic characteristics, program funding and data collection procedures. The types of monitoring programs included range from long-term, basin wide programs run by federal agencies to local-scale programs run by non-governmental organizations. Data from each of the listed sources are not held within the inventory, but contact information and direct hyperlinks to the web (when available) provide ready access. The inventory's website is hosted by the Great Lakes Information Network at: *http://mapserver.glc.org/website/lkstclair/search.htm*

The monitoring inventory can be easily searched; keywords can be used to locate projects by monitoring organization, project title and project description. A particular monitoring medium can be selected from a list which includes air, biota, land, sediments, soil, wildlife and water. Monitoring categories covered include chemical, fish or aquatic invertebrates, land uses, microbiological, physical and other wildlife. Categories of particular relevance to habitat and biodiversity concerns include macroinvertebrate sampling, assessment of habitat and natural communities and monitoring fish and wildlife community health.

GAP

In compiling the Lake St. Clair Monitoring Inventory, the Great Lakes Commission found that there has been little effort to coordinate monitoring programs addressing key environmental issues in the watershed.

GAP Analysis

Knowing the extent of current monitoring programs and understanding where gaps in monitoring lie can improve resource management decisions and inspire better coordination and collaboration among monitoring activities. A gap analysis based on a comparison of previously identified monitoring needs and the inventory of current monitoring programs was performed to address these issues. The gaps identified and recommendations to address them are discussed in the Lake St. Clair Monitoring Gap Analysis and Strategic Plan document, which is currently available at *www.glc.org/monitoring/stclair/pdf/StrategicPlan.pdf*

VI. B. 2. Michigan Natural Features Inventory

Michigan Natural Features Inventory (MNFI - *http://web4.msue.msu.edu/mnfi*) maintains records on the status and location of vulnerable natural communities and endangered, threatened and special concern species in Michigan. The Michigan Natural Features Inventory (MNFI) is uniquely qualified to conduct surveys for rare and exemplary natural features throughout the state of Michigan. MNFI has a team of experts in ecology, botany, zoology and aquatic zoology to prepare for and conduct field surveys for rare vascular plants and animals (insects, mammals, birds, mussels, snails, reptiles, amphibians and fish), as well as rare and/or high quality natural communities. MNFI has more than 20 years of experience conducting natural features inventories on a variety of scales including state parks, state forests, large military installations and entire counties.

GAP

Although MNFI maintains the most comprehensive database on rare species and natural communities in Michigan, this information is not complete.

Why conduct a natural features inventory?

Although MNFI maintains the most comprehensive database on rare species and natural communities in Michigan, this information is not complete. Data collection spans a long time frame (late 1800's to present) and many places have never been surveyed (or the information was never recorded). This is especially true for private land. An inventory can update older

CASE STUDY

Macomb County Michigan Natural Features Inventory

Michigan Natural Features Inventory (MNFI) performed in-depth research on the condition of natural features within Macomb County that included wetlands, woodlands, soils, rare plant and animal species and steep slopes. The program was initiated in Summer 2003 to assist county agencies and local municipalities to conduct more effective land use planning. The first draft was made available through the MNFI program in January 2004. It is available in Geographic Information Systems (GIS) format and supporting text is forthcoming. Following is the web link to the Macomb County MNFI report: *http://macombcountymi.gov/gis/Documents/Macomb_County_MNFI_report.pdf*

records, fill in the gaps where there are no documented survey information and provide a more accurate picture of biodiversity in a given area. This more complete package of information provides a strong foundation for making sound land use, natural resource management and conservation decisions.

How long does an inventory take?

Field inventory includes preparation (detailed aerial photo review, potential habitat delineation, development of rare species models and aerial flights to confirm or eliminate sites that lack merit for ground surveys) as well as the actual field work. Preparation can take anywhere from 3-6 months depending on the scale of work. The field inventory is typically conducted from spring through fall, depending on the best time to document the presence and condition of each natural feature. The whole process typically spans a 2-year time period which allows for suitable survey conditions to be selected.

HIGHLIGHT

Michigan Natural Features Inventory compiles, maintains and provides information on rare, threatened and endangered species and spaces in Michigan while the Natural Heritage Information Centre does this for Ontario.

How much does an inventory cost?

Local municipalities, regional units of government and/or conservation organizations can negotiate a contract with MNFI to conduct an inventory of natural features in their region. The type of surveys can range from a targeted group of animals such as rare grassland or forest birds to a comprehensive effort that incorporates natural communities, plants and animals. Costs are dependent on several factors including: size of the area to be surveyed, degree of effort, number and type of species targeted and number of sites. Other factors include: acres of natural vegetation, size and configuration of vegetation blocks, fragmentation of ownership and access to property.

VI. B. 3. Ontario Natural Heritage Information Centre

The Natural Heritage Information Centre (NHIC) of the Ontario Ministry of Natural Resources, is the Ontario counterpart to the Michigan Natural Features Inventory described above. As such, NHIC compiles, maintains and provides information on rare, threatened and endangered species and spaces in Ontario. This information is stored in a central repository containing a computerized database, map files and an information library, which are accessible for conservation applications, land use planning, parks and protected areas planning, etc. NHIC belongs to a network of similar centers established in each Canadian province, U.S. state and numerous Latin American and Caribbean countries, known as Natureserve.

The NHIC's overarching goal is to generate a permanent and dynamic atlas and data bank on the character, distribution and conservation status of natural areas, critical flora, communities and special features in Ontario. They assemble and organize information on endangered species and spaces from all available sources, ranging from atlas projects, naturalist groups, universities, museums and inventory monitoring programs by public and private sector agencies and organizations. Information is organized to be accessible for ecologically sound land use planning and in support of biodiversity protection programs.

Much of the collected information is available online through their website at: *www.mnr.gov.on.ca/MNR/nhic/nhic.cfm*. Users can search for information on occurrences of particular rare species, vegetation communities or natural areas in a variety of ways including by site name and by jurisdiction, such as township or county. With the use of the Mapguide plug-in, a link to which is available on the site, users can conduct geographic queries for species, plant communities and natural areas. Users can also create range maps of rare species. Finally, reports of rare species or vegetation communities can also be submitted online through the site.

The NHIC has provided facilities and scientific/technical input to numerous cooperative projects. Most recently, the NHIC was instrumental in The Big Picture 2002 Project, a Geographic Information System (GIS)-based landscape analysis, aimed at identifying the key natural heritage areas in southern Ontario and the most promising linkages between them. The maps produced through this project will help guide conservation efforts such as restoration, land securement and landuse planning. The Nature Conservancy of Canada has supported the project with funding and scientific input. A number of other organizations (Federation of Ontario Naturalists, Ducks Unlimited, Carolinian Canada, Ontario Power Generation and Ontario Parks) have provided valuable input through a peer review committee. Downloadable products from the project include a Powerpoint Presentation, poster, methodology, PDF images and GIS coverages.

FACT

The Centre also maintains the Ontario Herpetofaunal Atlas, which was initiated in 1984 as an attempt to consolidate existing information and gather new data on Ontario's amphibians and reptiles.

The Centre also maintains the Ontario Herpetofaunal Atlas (or Summary) (OHS), which was initiated in 1984 as an attempt to consolidate existing information and gather new data on Ontario's amphibians and reptiles. The primary purpose of the OHS project was to produce detailed distribution maps of the province's amphibians and reptiles. Field data submitted by volunteers has been supplemented by specimen records from museum and university collections in Ontario (e.g. Royal Ontario Museum and University of Guelph) and elsewhere (e.g. University of Michigan) and all were entered into the OHS database. In addition, records were extracted from published (e.g. journal articles) and unpublished (e.g. theses, park and natural area inventory reports) literature. Limited access to records in the Ontario Herpetofaunal Summary database is available for conservation, education, or research purposes.

VI. B. 4. USGS Great Lakes Gap Analysis Program

Initiated in 2001, the U.S. Geological Survey, in cooperation with several state natural resource-management agencies, began a Gap Analysis Program (GAP) in the Great Lakes Basin to evaluate the biological diversity of aquatic habitats and identify gaps in the distribution and protection of vulnerable species and their habitats. The GAP program aims to keep common species common by identifying those species and communities not adequately represented in existing conservation areas. The approach recognizes that protecting regions already rich in natural habitat enables protection of the animal and plant species that depend on them.[38] The GAP program has three distinct, yet interrelated components: the Great Lakes Regional Aquatic GAP; the Great Lakes Coastal GAP and the Great Lakes Riverine GAP.

Great Lakes Regional Aquatic GAP

The goal of Great Lakes Regional Aquatic GAP project valuate biological diversity of Great Lakes aquatic habitats and identify gaps in the distribution and protection of these species and their habitats. This effort supports an integrated approach in which common methods and protocols are established and results are comparable across the Great Lakes landscape. USGS aims to accomplish this through, building and maintaining partnerships with Gap stakeholders; delineation and mapping of ecologically similar drainage areas; classification of habitats in riverine and coastal areas, using regionally consistent methods; development of a central biological database for fish and invertebrates; mapping

known and predicted species distributions (modeling); completing an aquatic gap analysis and serving the data and analysis results on the Internet and on CD-ROM.

Great Lakes Riverine Gap

There are thousands of rivers and streams within the Great Lakes basin, providing habitats for fish and other aquatic organisms throughout various stages of their life cycles. These streams vary from warm water streams that support bass to cold water streams that support breeding populations of native trout. The purpose of the Riverine Aquatic Gap Analysis project is to identify gaps in the conservation of fish and other aquatic species in the rivers and streams of the Great Lakes basin. Riverine Gap projects are underway in Michigan, New York, Ohio and Wisconsin with completion scheduled for 2006. Gap Analysis in Minnesota, Illinois, Indiana and Pennsylvania is scheduled for 2004 to 2009. The Riverine Gap is collaborating with the Great Lakes Commission on Lake St. Clair, especially to address the riverine portion of the 10-mile buffer around Lake St. Clair.

FACT

There are thousands of rivers and streams within the Great Lakes basin, providing habitats for fish and other aquatic organisms throughout various stages of their life cycles.

Coastal Gap

The coastal zone is an important buffer and link between the open water and inland ecosystems of the Great Lakes basin and consists of a wide variety of habitats. The geomorphology of the coast ranges from sandy beaches and mud flats to sheer cliffs and headlands. This rich environment is home to approximately 120 native or established fish species, most of which use the nearshore areas throughout their life cycle.

GAP

Despite the various data and information sources, much is still unknown and undocumented about Great Lakes coastal habitats. The USGS Coastal Aquatic Gap Pilot Project is being undertaken to fill these gaps and thereby improve understanding of coastal habitats and enhance their diversity and protection.

Despite the various data and information sources, much is still unknown and undocumented about Great Lakes coastal habitats. The USGS Coastal Aquatic Gap Pilot Project is being undertaken to fill these gaps and thereby improve understanding of coastal habitats and enhance their diversity and protection. This project is intended to extend the Aquatic Gap Analysis tools being developed for riverine habitats to the nearshore habitats of the Great Lakes coasts. For this study, the nearshore zone will encompass the area from the shoreline to approximately 10 meters of depth. Nearshore fish distributions and assemblages are coupled with deep-water fish surveys by the USGS Great Lakes Science Center. The focus of the pilot projects is on the nearshore regions of western Lake Erie and eastern Lake Ontario and will be extended to all Great Lakes in the future. The Coastal Gap is collaborating with the Great Lakes Commission on the Coastal Habitat Conservation and Restoration Plan for Lake St. Clair.

Regional Central Database

Geospatially referenced biological and habitat data used for Aquatic Gap Analysis in the eight Great Lake states are being imported into a unified database structure in a regional central database at the USGS Great Lakes Science Center in Ann Arbor, Michigan. An OracleTM relational database with the capability to export the data into a Microsoft Access® database is being used. The database structure is based in part on the Nature Conservancy (TNC) and National Biological Information Infrastructure of USGS-BRD database designs, as well as the structure currently in use for the Ohio Aquatic Gap Analysis project. Protocols and mechanisms for data sharing based on ownership of the data are be-

ing developed. The Great Lakes Aquatic Gap project is capable of serving data to Great Lakes Aquatic Gap investigators using client-server or web-enabled tools.

Applications for Conservation of Biodiversity in the Great Lakes Region

Biodiversity conservation is of growing concern in the Great Lakes region and elsewhere because the focus of conservation has expanded beyond rare and endangered species to the full range of species or biodiversity. In 2000, The Nature Conservancy identified 271 sites as important for Great Lakes biodiversity, of which 60% were deemed "irreplaceable." Only 5% of these sites were protected.

> HIGHLIGHT
> In 2000, The Nature Conservancy identified 271 sites as important for Great Lakes biodiversity, of which 60% were deemed "irreplaceable." Only 5% of these sites were protected.

The Great Lakes Aquatic Gap project has been working closely with non-government agencies, universities, tribes and state and federal agencies charged with management of natural resources to provide useful tools for biodiversity conservation efforts. The Great Lakes Aquatic Gap Analysis Project will work with decision support system specialists in the National GAP program to develop appropriate decision support tools based on the GAP data and information generated.

VI. C. Local Planning Tools for Protecting Habitat

Local governments have been granted authority to plan and adopt ordinances protecting the public health, safety and welfare of residents. Over the last 20 years, there has been a growing recognition among local governments of the importance of sustainable land use practices to meet their health, safety and welfare responsibilities. Local governments have used their planning authority to develop community master plans, local ordinances and other programs that benefit their communities, including programs and practices to maintain and protect natural resources (upland and aquatic) in the form of parks for recreational opportunities, ensure clean groundwater and surface water as potable water sources and retain and replace trees in the urban areas to moderate temperatures, sequester carbon and to provide psychological relief from concrete and asphalt.

> HIGHLIGHT
> Although the focus and examples in this section are U.S. based, Canadian planning products, including Official Plans and Zoning by-laws, offer a similar and equally important framework for habitat conservation and restoration.

Section II. D. 1. describes land use laws and the planning processes in the U.S. and Canada. This section describes how particular products of the U.S. local planning process establish an overarching framework for habitat conservation and restoration. Although the focus and examples in this section are U.S. based, Canadian planning products, including Official Plans and Zoning by-laws, offer a similar and equally important framework for habitat conservation and restoration.

VI. C. 1. Community Master Plans

Effective regulation of land use that provides for protection of the environment begins with comprehensive planning. The community master plan, sometimes referred to as a comprehensive plan, should reflect the community's vision of itself and how it wants to grow or develop. The strength and effectiveness of the master plan is determined by its

CASE STUDY
St. Clair County Master Plan

The St. Clair County Comprehensive Master Plan, adopted by the County Board of Commissioners in 2000, defines long-range goals and intentions of the community regarding the nature and direction of future physical development and public investment within the county. It consists of elements addressing land use and land use change, transportation, the environment, the economy and public facilities services and infrastructure. Several maps developed for the master plan have bearing on coastal habitat conservation and preservation. Directions on obtaining copies of the master plan, technical reports and maps can be found online at: www.stclaircounty.org/offices/metro/comprehensive.asp

goals, policies and recommended projects, as well as the established link between them. A zoning plan is a required element of city and village master plans, while township and county master plans may consist simply of generalized future land use maps. Michigan law now requires that every community have a land use master plan (See Section II.D.1). The communities must evaluate their plan every five years to determine its continued relevancy to the community.

Communities can use the master planning process to effectively maintain and shape their community character. Establishing natural resource protection policies is an important aspect of that process. Local governments, depending upon their situation, can use the master plan to address such environmental issues as habitat preservation, wetland protection, wellhead protection, sanitary sewer planning, woodlands preservation and establishment of greenways.

A capital improvements plan (CIP) is an important tool for financing capital improvements such as water and sewer infrastructure and other capital projects. A CIP should describe the capital improvement projects and list sources of revenue and expenditures by year. Communities should consider integrating the CIP into their master plan. In doing so, capital improvement projects are linked to the goals and policies of the master plan as well as to the overall responsibility of protecting the health, safety and welfare of residents. A CIP, for example, can include policies for the protection of natural resources that regulate placement of utilities to minimize disruption of important habitat areas as well as reduce the threat of contamination to ground water and surface water resources.

VI. C. 2. Local Ordinances

A master plan, through its goals, policies and recommended projects, provides the vision for how a community will develop. Regulations governing development (i.e., land use and subdivision control regulations) for a community are found in the Zoning Ordinance and or other related special ordinances.

Studies have shown that the patterns of development in Michigan and particularly in coastal areas of Michigan are highly land consumptive. Michigan has one of the nation's highest ratio's of urbanized land per capita (i.e., low number of persons per urbanized acre). Researchers and planning experts have criticized Michigan for its low density, land consumptive, high impact development patterns. While zoning ordinances have often driven this trend, they can also be used to correct this trend, through planning tools such as compact development, open space preservation and natural features ordinances.

HIGHLIGHT

Researchers and planning experts have criticized Michigan for the predominance of local ordinances that foster low density, land consumptive, high impact development patterns.

Local ordinances often contain design standards. These guidelines and regulations determine the design requirements for projects. For example, a storm water management ordinance may require the use of best management practices (BMPs), such as vegetated swales for controlling runoff. The design standards of the ordinance may establish guidelines for the construction of the swale as well as the desired velocity of the water's movement through the structure.

CASE STUDY
Model Environmental Ordinances for Macomb County Communities

As part of a recently completed planning initiative, a five part series of model ordinances provides a "suite" of environmental applications that will assist Macomb County communities in completing the second part of the MNFI program and will assist the county in meeting many parts of the Phase II requirements of their storm water National Pollutant Discharge Elimination System (NPDES) permit. The model ordinances consist of the following samples: a) Storm Water Management; b) Woodlands/Tree Ordinance; c) Resource Overlay District; d) Natural Feature Setback/Buffering; e) Floodplain Management; and f) Native Landscaping Ordinance and Guidelines. These model ordinances are designed to allow local communities to determine how they might best fit within their own communities or if they are even appropriate for their particular needs.

HIGHLIGHT
A community can regulate the impacts of development on the environment most effectively through the tandem use of its master plan and local ordinances that have been developed and revised with efficient land development and habitat protection in mind.

While the regulations of a local ordinance can be challenged in court, a community strengthens its case if the ordinance is based on and reflects the provisions of its master plan.

A community can regulate the impacts of development on the environment most effectively through the tandem use of its master plan and local ordinances that have been developed and revised with efficient land development and habitat protection in mind. Communities in Southeast Michigan are encouraged to protect their natural resources by updating their master plans as well as through the establishment of local ordinances. A number of resource publications developed by SEMCOG can assist in this effort:

- *Land Use Tools and Techniques: A Handbook for Local Communities*
- *Opportunities for Water Resource Protection in Local Plans, Ordinances and Programs: A Workbook for Local Governments*
- *Opportunities for Water Resource Protection in Local Plans, Ordinances and Programs: A Workbook for Local Governments*

They are described in greater detail in the Endnotes[39] of this section and are available online at www.semcog.org/Products/Publications/index.htm.

VI. C. 3. Watershed Planning

Approximately 170 local governments across Southeast Michigan are regulated by the federal Phase II Storm Water Rule. The rule, which was issued by the U.S. Environmental Protection Agency, required municipalities and other public bodies that operate a separate storm water drainage system within a U.S. Census-defined Urbanized Boundary to obtain a storm water permit by March 10, 2003. This permit program is administered by the Michigan Department of Environmental Quality (MDEQ). Under the program, communities needed to apply for one of two different kinds of permits:

HIGHLIGHT
Watershed based permits offer the advantages of maximum flexibility in determining and prioritizing actions, greater cost sharing options and grant funding opportunities. Most communities in southeast Michigan are regulated by the Phase II Storm Water Rule are operating under the watershed-based permit.

> Watershed based permits offer the advantages of maximum flexibility in determining and prioritizing actions, greater cost sharing options and grant funding opportunities. Most communities in southeast Michigan are regulated by the Phase II Storm Water Rule are operating under the watershed-based permit. This option requires cooperation among communities within the subwatershed to perform the necessary planning and implementation. This includes such components as a watershed management plan, an illicit discharge elimina-

tion plan (IDEP), public involvement plan (PIP), public education plan (PEP) and a storm water pollution prevention initiative (SWPPI) requiring the identification of storm water control activities that the community will undertake.

Jurisdictional-Based Permits require the submission of a storm water management plan (SWMP). The SWMP must include such components as an illicit discharge elimination plan, construction storm water runoff controls, public involvement plan and a public education plan. This permit does not require cooperation with neighboring communities or submission of a watershed management plan, but the permit requires more prescriptive control measures for storm water management.

Most communities in Southeast Michigan that are regulated by the Phase II Storm Water Rule are operating under the watershed-based permit. Communities across the seven county SEMCOG region are collaborating in 26 subwatershed groups.

Preservation of habitat is an important tool for maintaining water quality and is often incorporated into watershed or subwatershed plans. These plans become the vision and road map for improving the watershed and achieving the requirements of the Phase II Storm Water Rule. Establishing recommended projects that preserve, create or enhance habitat is an effective way to promote habitat protection through the watershed planning process.

Public Education and Involvement

The Phase II Storm Water Rule has a number of public education and involvement requirements. It is recognized that individuals' actions play a key role in successfully eliminating pollution and preserving habitat. Local governments involved in the watershed planning process are collaborating on the development of public education and participation materials that can be used by all watershed groups to help meet their public education and participation requirements.

CASE STUDY
Southeast Michigan Partners for Clean Water

This partnership, composed of representatives of local and county government, watershed councils and consulting experts, formed to collaborate for developing public education and involvement materials that can be used by all watershed groups to help meet these Phase II permit requirements. The partnership recently launched a number of successful outreach efforts to both inform the public as well as gauge public knowledge on water quality issues. The first initiative is a public education outreach campaign entitled "Our Water. Our Future. Ours to Protect.–Seven Simple Steps to Clean Water." The campaign uses tip cards, brochures, posters and displays to raise public awareness of how individuals can all help maintain and improve our water resources.

The second initiative consisted of a regional water quality outreach survey to determine the water quality perspectives of the public. The information garnered from the survey will assist the partners in developing new programs to assist them in complying with the requirements of their storm water permit. More information on the "Our Water. Our Future. Ours to Protect." public education campaign is available online at: *www.semcog.org/OursToProtect/OurstoProtect.htm*

Two resource publications by SEMCOG that support watershed planning in the study are:

- *Comparing 2000 Census and 2030 Regional Development Forecast by Watershed*
- *Managing Fertilizer to Protect Our Water Resources*

They are described in the Endnotes[40] of this section and are available online at: *www.semcog.org/Products/Publications/index.htm*.

Macomb and St. Clair Counties play both a fiduciary as well as facilitative role in the watershed planning process. In Macomb County, the Department of Public Works oversees the distribution of the federal grant for watershed planning from the Army Corps of Engineers. County staff members also facilitate meetings of the six subwatershed groups. In St. Clair County, the Division of Environmental Health acts as the fiduciary agent for the watershed planning process. County health staff also facilitates meetings of the four subwatershed groups.

VI. C. 4. Regional Planning Process

The regional planning process provides a framework for informing as well as coordinating local government collaboration on planning issues. SEMCOG, the Southeast Michigan Council of Governments, either facilitates or provides significant input to many of these regional coordinating functions.

SEMCOG is the regional planning agency for Southeast Michigan. SEMCOG is a council of governments in which local officials from 147 communities participate to prepare and adopt regional plans and policies on issues that cross jurisdictional boundaries. This includes such issues as water quality, air quality, land use issues such as solid waste and transportation.

SEMCOG's water quality planning activities are guided by the *Water Quality Management Plan for Southeast Michigan* (October 1999). The provisions of the federal Clean Water Act of 1977 required SEMCOG to prepare an areawide water quality plan that would bring local governments into conformance with the Act. The *Water Quality Management Plan for Southeast Michigan* (the Plan) was adopted in 1978 and focused mainly on controlling point sources from such facilities as publicly owned treatment works. In the 1999 update, the Plan shifted emphasis from point source to nonpoint source pollution and from end of pipe control strategies to improved water quality through watershed planning and management.

HIGHLIGHT

Regional planning offers the opportunity to maximize benefits of protection and minimize impacts of development on coastal habitat.

The Plan provides the basis for SEMCOG's water quality planning initiatives. It led to development of the publications listed throughout this section and providing assistance in water quality protection to Southeast Michigan governments. SEMCOG has developed three documents that assist local governments in meeting their water quality and environmental protection responsibilities:

Putting Southeast Michigan's Water Quality Plan Into Action: Tools for Local

Investing in Southeast Michigan's Quality of Life: Sewer Infrastructure Needs

Options for Local Government Funding of Water Quality Activities

They are described in the Endnotes[41] of this section and are available online at:
www.semcog.org/Products/Publications

Section VI Endnotes

1. Mysz, A., Reid, R. & Rodriguez, K., 1998. Biodiversity Investment Areas; Nearshore Terrestrial Ecosystems - Draft for discussion at SOLEC 98. State of the Lakes Ecosystem Conference 1998.

2. CH2MHILL, Fortin Environmental Economics & Ecologistics Limited, 2001. A Proposed Wetland Restoration Project - Lake St. Clair - Final Report. Prepared for Eastern Habitat Joint Venture- Lake St. Clair Technical Committee.

3. Chesky, E. D., & Wilson, W. G., 2001. Eastern Lake St. Clair Important Bird Area Conservation Plan. Produced for the Eastern Lake St. Clair IBA Steering Committee and Stakeholders.

4. Wetlands International, 2004. In: Directory of Wetlands of International Importance. Accessed 21 Dec. 2004: www.wetlands.org/RDB/Ramsar_Dir/Canada/CA016D02.htm

5. Jacobs, C. 2004. Walpole Island: Issues Paper. Prepared for the Great Lakes Commission.

6. Personal Communication. Clint Jacobs, Walpole Island Heritage Centre, 2004.

7. *Ibid.*

8. Wetlands International, 2004. In: Directory of Wetlands of International Importance. Accessed 21 Dec. 2004: www.wetlands.org/RDB/Ramsar_Dir/Canada/CA016D02.htm

9. Natural Heritage Information Centre. Natural Areas Report: St. Clair National Wildlife Area. Accessed 29 July 2004: www.mnr.gov.on.ca/MNR/nhic/areas/areas_report.cfm?areaid=5065

10. CH2MHILL, Fortin Environmental Economics Ecologistics Ltd., 2001. A proposed wetland restoration project- Lake St. Clair: Final Report. Prepared for Eastern Habitat Joint Venture/Le PlanConjoint des Habitats de l'Est, Lake St. Clair Technical Committee.

11. Michigan Department of Natural Resources, 2004. Algonac State Park. Accessed 20 November 2004: www.michigandnr.com/parksandtrails/ParksandTrailsInfo.aspx?id=433

12. Palmgren, G., 2001. Stewardship Management Plan: Algonac State Park. Prepared for the State Park Stewardship Program, Michigan Department of Natural Resources, Lansing, MI.

13. *Ibid.*

14. MDNR, 2004. Wetzel State Recreation Area. Accessed: 21 Dec. 2004: www.michigandnr.com/parksandtrails/ParksandTrailsInfo.aspx?id=507

15. Bauer, R., Marcelus, C., Herman, K& Austin, M., undated draft review. Natural Heritage Management Plan for St. Clair Flats Wildlife Area and Algonac State Park. NATURAL Heritage Program, Michigan Department of Natural Resources.

16. Bauer *et. al.*, undated, *op cit.*

17. Greater Detroit American Heritage River Initiative Website, 2004. Goose Bay Shoreline Stabilization and Habitat Enhancement. Accessed 21 Dec. 2004: www.tellusnews.com/ahr/se@goose_bay.html

18. Michigan Department of Natural Resources, 2004. Michigan Natural Resources Trust Fund – Projects to date. Accessed 23 Dec. 2004: www.michigan.gov/dnr/1,1607,7-153-10366_11864---,00.html

19. Fortin Environmental Economics Ecologistics Limited, April 2001. A Proposed Wetland Restoration Project - Lake St. Clair. Prepared for The Eastern Habitat Joint Venture, Lake St. Clair Technical Committee.

20. Trust for Public Land, 2004. 410-Acre Humbug Marsh Acquired. Accessed: 20 November 2004: www.tpl.org/tier3_cd.cfm?content_item_id=12705&folder_id=666

21. Land Trust Alliance website 2004. What is a Conservation Easement? Accessed 29 July 2004: www.lta.org/conserve/easement.htm

22. Little Traverse Conservancy website, 2005. What is a Conservation Easement? Accessed 4 January 2005: http://landtrust.org
Little Traverse Conservancy's website also offers an example of a conservation easement in Michigan with model language covering a wide array of contingencies and conditions.

23. Environment Canada, Ontario Region, 2003. The Ontario Ecogifts Handbook 2003. Additional information is available online at: www.on.ec.gc.ca/ecogifts

24. Ontario Parks, 2003. Species at Risk: Recovery. Accessed 17 January 2005: www.ontarioparks.com/english/sar-recovery.html

25. Hector, D, 2000 . MacDonald Park Wetland and Prairie Restoration Project, St. Clair River, Ontario, Canada. Chapter 4 in: Best Management Practices for soft engineering of shorelines. Accessed 20 January 2005: www.tellusnews.com/ahr/report_chapter4.html

26. Upper Thames River Conservation Authority, 2003. Recovery Plan Development. Accessed 17 Jan 2005: www.thamesriver.org/Species_at_Risk/recovery_plan_development.htm

27. Upper Thames River Conservation Authority, 2003. Aquatic Species at risk in the Thames River Watershed. Accessed 17 January 2005: www.thamesriver.org/Species_at_Risk/species_at_risk.htm

28. Ontario Parks, 2003. Species at Risk: Recovery. Accessed 17 January 2005: www.ontarioparks.com/english/sar-recovery.html

29. Upper Thames River Conservation Authority, 2003. Recovery Plan Development. Accessed 17 January 2005: www.thamesriver.org/Species_at_Risk/recovery_plan_development.htm

30. Environment Canada, 2003. Recovery Plan Summary No. 25 - Sydenham River: An Ecosystem Approach. Accessed 17 January 2003: www.speciesatrisk.gc.ca/publications/abstractTemplate.cfm?lang=e&id=9

31. Environment Canada, 2003. Species at Risk. Accessed 17 January 2005: www.speciesatrisk.gc.ca/publications/newsletter/june03/profile_e.cfm

32. Lake St. Clair Management Plan – final draft, 2003. Accessed 18 January, 2005: www.glc.org/stclair/pdf/ch9_implementation_july2003.pdf

33. Environment Canada, 2003. Draft Version: The Lake St. Clair Canadian Watershed Technical Report: an examination of current conditions December 30, 2003.

34. Ducks Unlimited Website. Accessed 20 January 2005: www.ducks.org/about/index.asp

35. For more information on the program in southeastern Michigan, please contact:
Dan Kennedy
Rose Lake District Office
8562 E. Stoll Rd.
East Lansing, MI 48223
kennedyd@michigan.gov

36. USFWS, 2004. Partners for Fish and Wildlife – Michigan. Accessed 12 December 2004: http://partners.fws.gov/pdfs/MI-needs.pdf

37. NRCS, 2003. Rare & Declining Habitat (Lakeplain Wet Prairie) Design Worksheet CRP CP25.

38. Morrison SS, Passino-Reader DR, Myers DN, McKenna JE, Stewart J, Scudder BC, Lohman K, Aichele S (2003) Great Lakes Regional Aquatic Gap Analysis-Preserving biodiversity in the Great Lakes Basin. USGS GLSC Fact Sheet 2003-1, 6 pp.

39. *Land Use Tools and Techniques: A Handbook for Local Communities* (March 2003): This handbook provides current techniques for addressing local land use decisions with the goal of positively impacting local communities and the Southeast Michigan region. Numerous case studies and examples of the techniques are provided in the handbook.

Opportunities for Water Resource Protection in Local Plans, Ordinances and Programs: A Workbook for Local Governments (August 2002): This workbook provides planning and design tools for addressing water quality protection. It is designed to provide local governments with a continuum of options for preserving and restoring water resources and demonstrating the connections between plans and ordinances.

40. *Comparing 2000 Census and 2030 Regional Development Forecast by Watershed* (July 2002): This report provides population, households and job data by watershed. It is intended to assist local governments from across Southeast Michigan in their water quality planning efforts, including watershed planning and implementing the storm water permit program.

Managing Fertilizer to Protect Our Water Resources (December 2002):This paper describes fertilizer as a potential pollutant source, clarifies local government's capabilities to reduce this pollutant source, outlines options to reduce the impacts through education and regulation and recommends ways to resolve these issues.

41. *Putting Southeast Michigan's Water Quality Plan Into Action: Tools for Local Government* (June 2000): This document builds on the goals, policies and recommendations from the Water Quality Management Plan that focus on local governments' actions in water quality protection.

Investing in Southeast Michigan's Quality of Life: Sewer Infrastructure Needs (April 2001): This document identifies the fiscal resources needed to sustain and improve Southeast Michigan's aging sewer system over the next 25 years. Maintaining and improving the sewer infrastructure is an important tool for improving water quality and the aquatic habitats of Southeast Michigan's lakes and rivers.

Options for Local Government Funding of Water Quality Activities (April 2003): This document summarizes the types of local water quality programs in need of funding, the options available for raising the local revenue and some advantages and disadvantages for local officials to consider.

Section VII. New Management Tools For Lake St. Clair Coastal Habitat Restoration and Conservation

New tools and resources were developed for this project, both to augment the available information on the natural areas within the Lake St. Clair region and to assist planners with effective conservation and restoration planning. The suite of tools will assist users in evaluating local land use changes, identifying trends and prioritizing undeveloped lands for conservation and restoration activities. They include new data, analyses based on the best possible information at the present time and tools to easily replicate these analyses as conditions change or better data become available. Resources and tools include:

- Coastal Change Analysis Program (C-CAP) land cover and land cover change products
- A Potential Conservation Area (PCA) analysis
- An Integrated Coastal Management (ICM) Tool

HIGHLIGHT

The tools will assist users in evaluating local land use changes, identifying trends and prioritizing undeveloped lands for conservation and restoration activities.

The National Oceanic and Atmospheric Administration's (NOAA) C-CAP has developed a product derived from Landsat Satellite land cover data that reflects changes in land cover within the nation's coastal zone. Change products quantify the actual change from one land cover type to another, showing where and how much land has changed within a specific period of time. These products make it simple to determine where, for example, conversion of farm land to low intensity development is occurring and how much area is involved. They also can be used to quantify the extent of development occurring along the coastline or the amount of land that remains in an undeveloped state. C-CAP land cover and land cover change products are designed to assist coastal resource managers in their decision-making processes. These national data sets can be used to assess urban growth, determine changes to natural resources and develop trend analyses. The C-CAP data is a component of the PCA analysis and the foundation for the ICM Tool.

Using both C-CAP data and additional data sources, Michigan Natural Features Inventory (MNFI) has created a Potential Conservation Area (PCA) analysis and map for the project area. PCAs are defined as places on the landscape dominated by native vegetation that have various levels of potential for harboring high quality natural areas and unique natural features. Sites are ranked based on seven criteria developed by MNFI: total size of site, size of core area, stream corridor presence, landscape connectivity, restorability of surrounding lands and presence of rare species. PCAs can help prioritize sites for future field surveys, land conservation and developing large scale open space systems of linked natural areas.

HIGHLIGHT

The Integrated Coastal Management tool helps local planners and resource managers compare the ecological impacts of different management decisions.

As a primary goal of the project, the NOAA Coastal Services Center (CSC) has also developed an Integrated Coastal Management (ICM) tool that helps local planners and resource managers to compare the ecological impacts of different management decisions. The tool utilizes information collected from around the watershed to identify potential priority areas for coastal habitat conservation and restoration efforts, making it possible for local planners to replicate the PCA analysis process as conditions change and data improve and also to create scenarios for more generalized land use planning.

FACT

Local agency and organization participation in the development and review of the ICM Tool helped to ensure it was tailored to local needs.

The tool was developed in close consultation with project management team members. Land use decisions are made primarily at the local level and have a great impact on coastal habitat. Accordingly, local agency and organization participation in the development and review of the ICM Tool was a priority and helped to ensure that the ICM Tool was tailored to local needs. Ultimately, the ICM tool will improve existing resource management efforts by integrating available ecological, environmental and socio-economic data and providing the framework for coastal habitat restoration and conservation planning for Lake St. Clair.

VII. A. C-CAP Products and Application

Introduction to NOAA's Coastal Change Analysis Program (C-CAP)

C-CAP is dedicated to the development, distribution and application of land cover and change data for the nation's coastal zone. C-CAP land cover and land cover change products are designed to assist coastal resource managers in their decision-making processes. These national data sets can be used to assess urban growth, determine changes to natural resources and develop trend analyses. The C-CAP products contain land cover data for two dates, approximately 5 years apart and a change product illustrating the difference between the two dates. All C-CAP products are derived from Landsat Satellite imagery, have a 30 meter pixel resolution, target an 85% overall classification accuracy and contain 22 land cover classes. C-CAP is part of the Coastal Remote Sensing Program of the NOAA Coastal Services Center, located in Charleston, South Carolina.

HIGHLIGHT

C-CAP's national land cover data sets can be used to assess urban growth, determine changes to natural resources and develop trend analyses.

VII. A. 1. Development of C-CAP

C-CAP Protocols

The development of any C-CAP product follows the C-CAP protocol as defined in Dobson and others, 1995. The national scope C-CAP demands a standard protocol ensuring compatibility and comparability of data. The protocol defines the general steps required to conduct national C-CAP development. These steps are as follows:

1. State the region change detection problem
    a. Define the region
    b. Specify the frequency of change detection
    c. Identify classes of the classification system
2. Consider significant factors
    a. Remote Sensing considerations
        i. Temporal resolution
        ii. Spatial resolution
        iii. Spectral resolution
        iv. Radiometric resolution
        v. Preferred C-CAP remote sensing system
    b. Environmental considerations
        i. Atmospheric conditions

ii. Soil moisture conditions
iii. Vegetation phonological cycle
iv. Tidal stage

3. Conduct image processing
    a. Acquire appropriate data
    b. Preprocess multiple-date remotely sensed data
    c. Select appropriate change detection algorithm from C-CAP alternatives
    d. Apply appropriate image classification logic – if necessary
    e. Perform change detection using GIs algorithms
4. Conduct quality assurance and control
5. Distribute results

C-CAP Classification Scheme

The following classification scheme is generally used for C-CAP products and was also applied to the Michigan and Ontario portions of C-CAP. Not all of the classes were used in the final product, such as the entire set of estuarine classes, tundra and snow/ice.

Integrated Forest Monitoring, Assessment and Prescription (IFMAP) Classification

Color	Class Name	Definition
	High Intensity Developed	Urban land cover with greater than 75 percent impervious surface
	Low Intensity Developed	Urban land cover with greater than 25 percent and less than 75 percent impervious surface
	Cultivated land	Active agriculture, orchards and vineyards
	Grassland	Both managed and managed grasslands
	Deciduous Forest	Hardwood forest with a pronounced seasonal dormancy period
	Evergreen Forest	Forest without a pronounced seasonal dormancy period
	Mixed Forest	Forest not dominated by either deciduous or evergreen species
	Scrub/Shrub	Woody vegetation less than 20 feet tall
	Palustrine Forest	Freshwater wetland forest
	Palustrine Scrub/Shrub	Freshwater wetland scrub/shrub
	Palustrine Emergent	Freshwater wetland-rooted emergent species (marsh, lilies, etc.)
	Estuarine Forest	Saltwater wetland forest greater than 20 feet (mangrove)
	Estuarine Scrub/Shrub	Saltwater wetland scrub/shrub (mangrove)
	Estuarine Emergent	Saltwater wetland emergent species (Spartina marsh, juncus grass, etc.)
	Unconsolidated Shore	Tidal flats, shoals and intertidal areas
	Bare Land	Bare exposed rock, sand and soil
	Water	Open water
	Palustrine Aquatic Bed	Floating vegetation and algal communities
	Estuarine Aquatic Bed	Marine algal communities
	Tundra	Permafrost and pariglacial conditions and communities
	Snow/Ice	Perennial snow and ice

The late-date (circa 2000) C-CAP map was created from a pre-existing IFMAP classification as created by Space Imaging for the Michigan Department of Natural Resources.

Additional Development of C-CAP for Canadian and Walpole Island Portions of Lake St. Clair

In addition to the development of the Michigan C-CAP data set, data was also collected for a 10-mile area adjacent to the lake including the islands of the delta. In contrast to the Michigan data set, the Lake St. Clair data was not developed from an existing product but was developed directly from the Landsat images. An accuracy assessment was not conducted for the additional data and the C-CAP standard of 85% overall accuracy may not be applied to these data.

Data Availability

The C-CAP data sets for the state of Michigan and the Lake St. Clair portions of Canada and Walpole Island are publicly available for download at the NOAA Coastal Services Center's web site (www.csc.noaa.gov/crs/lca/stclair.html). Metadata is included with the data download.

VII. A. 2. Limitations of C-CAP

Map Scale

Scale in landscape ecology is referred to as "grain size." This is a term to describe discrete habitat fragments in the landscape. Scale to a cartographer describes the relationship between the distance on the map and the distance on the ground. Large geographic scale means small area and high detail, whereas small geographic scale means large area and small detail. Scale in a vector (points, lines and polygons) context refers to the amount of detail you retain, or error you are willing to tolerate in your data. It also refers to the size of objects at a given spatial coverage. For instance, U.S. Geological Surgery (USGS) National Mapping Accuracy Standards for 1:24,000-scale mapping mandate that 90 percent of the features in the spatial coverage be within 14 meters of their exact location on the face of the Earth. At 1:24,000 scale, a .5 millimeter line (fine pencil width) covers 12.5 meters on the ground. Therefore, the smallest object you can resolve on a 1:24,000 scale map must be at or about the size of 14 meters.

FACT

Large geographic scale means small area and high detail, whereas small geographic scale means large area and small detail.

Resolution in a raster (grid cells or pixels) context refers to the smallest unit of area covered by a single pixel. Therefore, a 30-meter pixel would cover an area of 30 meters x 30 meters (900 square meters) on the ground. The smallest observable feature in a raster takes 4 contiguous pixels to be reliably identified. This is known as the Nyquist Frequency. To determine the appropriate resolution for your applications, you must determine the smallest feature you want to resolve and the pixel size must be half the smallest dimension of the feature in question. For instance if you want to find a car (10 x 6 feet), then your pixel size must be 0.5 x 6 feet = 3 feet to reliably identify cars in a raster context.

In a raster context, linear features, such as roads, can be extracted at or about the base resolution of the image. So, the scale of linear features extracted from raster imagery is approximately equal to the resolution. However, to extract polygonal features (areas) you need to base your error tolerances on a minimum of 4 pixels to reliably identify features. Therefore, the scale of area features is approximately twice the resolution of the imagery. For example, to delineate a road feature from a 30-meter image, you can extract a line representing the road with 30-meter accuracy, or approximately 1:50,000 scale. If you want to delineate wetland polygons in the landscape, your smallest reliable polygon must be 4 pixels (or 60-meter accuracy), which is approximately 1:100,000 scale. Scale and resolution are related, but not directly so. Therefore, it is most common to separate the two terms and refer to scale in a vector context and resolution in a raster context.

C-CAP data are mapped at 1:100,000 scale in a raster format with 22 standard classes constituting major landscape components. The data are not jurisdictional (cannot be used for permitting) and will not identify individual species. This scale of mapping means that the data should be within 60 meters of the exact location on the Earth 90 percent of the time according to U.S. Geological Survey (USGS) National Mapping Accuracy Standards. It is important to remember that C-CAP data maintain accuracies of 85 percent as a general rule. Some land cover classes will be higher, some lower. Within these data sets, 85 percent accuracy also means 15 percent inaccuracy. There certainly will be errors, but C-CAP has taken logical steps to minimize errors and has done extensive fieldwork to eliminate them.

VII. A. 3. Examples of C-CAP Protocol Application Nationwide

C-CAP products are useful for identifying regional landscape patterns and major functional niches (habitat) and for environmental impact assessment, urban planning and zoning applications. There are two examples of C-CAP application nationwide which are presented here for the reader's information.

Louisiana's Mermentau River Basin

Louisiana's lower Mermentau River Basin fronts the Gulf of Mexico and is vital to many sport and commercial fisheries. In fact, as much as 16 percent of the nation's fisheries harvest, including shrimp, crabs, crayfish, oysters and many fin fish, comes from Louisiana's coast (U.S. Department of Commerce, 1996). In addition, migrating birds, especially ducks and geese, winter in the basin. The river basin is marked by numerous national and state refuges and protected areas that serve as critical habitat for hundreds of thousands of waterfowl and other wildlife. Across Louisiana, critical wetlands, such as those in the Mermentau River Basin, are at risk. Louisiana has lost up to 40 square miles of marsh a year for several decades. If the current rate of loss is not slowed, by the year 2040 an additional 800,000 acres of wetlands will disappear and the Louisiana shoreline could advance inland as much as 33 miles in some places. Changes like these could seriously impact the health of Louisiana's fisheries and wildlife, while increasing the risks of coastal communities to erosion and other hazards.

HIGHLIGHT

C-CAP products are useful for identifying regional landscape patterns and for environmental impact assessment, urban planning and zoning applications.

The state's wetlands are being damaged by human activities such as intensive development, nonpoint source pollution, agricultural runoff and oil exploration. Storms, sea-level rise, subsidence or the gradual deterioration of soil and other natural causes also threaten marshes. Recently, a new problem has appeared. Coastal marsh dieback, also known as "brown marsh," is the rapid and unusual browning of smooth cordgrass (Spartina alterniflora). This browning first began during the spring of 2000, long before marshes usually turn brown in the fall. The phenomenon has been observed in parts of Texas and Florida, but is mostly found in coastal Louisiana. In some cases, dense vegetation has been converted to open mud flats with only a few plants. If coastal marsh dieback continues or intensifies, the loss of vegetation could result in rapid subsidence and erosion of the unstable marsh soils. This, in turn, would leave coastal communities vulnerable to direct exposure from hurricanes and tidal surges.

FACT

Across Louisiana, critical wetlands, such as those in the Mermentau River Basin, are at risk. Louisiana has lost up to 40 square miles of marsh a year for several decades.

For southwestern Louisiana's Mermentau River Basin, the 1990 to 1996 land cover classifications were derived from Landsat Thematic Mapper (TM) imagery from three different years: 1990, 1993 and 1996. Coastal Change Analysis Program (C-CAP) change analysis methodology was used to characterize changes to the landscape over these years

HIGHLIGHT

By conducting a change analysis for the affected areas and comparing that to a baseline map of Louisiana's coast, managers can determine what is happening to the wetlands on a large scale, what the wetlands were converted to and how fast and in what areas the changes have occurred.

by comparing the landscape in one year to that of the next year. The resulting change data were analyzed to identify changes to the wetlands. By conducting a change analysis for the affected areas and comparing that to a baseline map of Louisiana's coast, managers can determine what is happening to the wetlands on a large scale, what the wetlands were converted to and how fast and in what areas the changes have occurred.

Unlike most of Louisiana, estuarine (saltwater) marshes in the Mermentau River Basin actually increased during the last decade. Palustrine (freshwater) marshes and mature forested wetlands remained relatively stable. This is good news for coastal managers in the Mermentau River Basin, at least for the moment. For now the basin is free of brown marsh and wetland loss and the managers can use the satellite-derived land cover data as a baseline data set for comparison if the disease should ever impact the area. Land cover data helped the managers sketch the big picture of the health of the marsh. Managers in Louisiana have already started (or plan to continue) using Landsat imagery to look at the larger picture of the health of Louisiana's coast.

Using the big picture as a guide, managers can identify wetlands that need a closer look and supplement the satellite-derived data with other remote sensing technologies. Some of these methods include fixed-wing transects, helicopter transects and aerial photography. Fixed-wing and helicopter surveys are key in locating and determining the extent of marsh dieback. Aerial photography is important in providing high-resolution imagery for studying marsh dieback in relation to adjacent wetland areas.

Barnegat Bay, New Jersey, Data Synthesis Project: Habitat Loss and Alteration

During the last 50 years, development has exploded along Barnegat Bay, a shallow, lagoon-type estuary located on the coast of central New Jersey. The bay and its 42 miles of shoreline offer many recreational activities such as boating, fishing and swimming. In addition, the estuary is ecologically important as a breeding ground for oysters, clams, blue crabs and many other commercially important fish. Protecting and managing the habitats of Barnegat Bay benefits the citizens of New Jersey not only by reducing damage to natural ecological systems that provide homes for a myriad of terrestrial and aquatic species, but also by preserving open space and multiuse recreational areas in a region characterized by dense residential and commercial development. In 1995, after Barnegat Bay became part of the Environmental Protection Agency's National Estuary Program, work started on a long-range Comprehensive Conservation and Management Plan (CCMP) to minimize the harmful impacts of future development. As a part of this effort, the Rutgers University Center for Remote Sensing and Spatial Analysis (CRSSA) generated the Barnegat Bay Data Synthesis Project: Habitat Loss and Alteration. This comprehensive plan incorporated historical data, National Wetland Inventory data, benthic maps, satellite-derived digital land use/land cover data and aerial photography to assess long-term changes to habitat.

HIGHLIGHT

Protecting and managing the habitats of Barnegat Bay benefits the citizens of New Jersey by reducing damage to natural ecological systems and by preserving open space and multiuse recreational areas.

The base map for the data synthesis project's comprehensive mapping is land use/land cover data, produced by the Rutgers University Center for Remote Sensing and Spatial Analysis (CRSSA). Satellite-derived land cover data were developed from Landsat Thematic Mapper 1994/95 imagery using the NOAA

C-CAP protocol (Dobson and others 1995). The initial land cover data set was augmented and adapted specifically for the Barnegat Bay Estuary Program. The Barnegat Bay data set incorporated 38 different land covers. This land use/land cover base was combined with U.S. Fish and Wildlife Service National Wetland Inventory maps, submerged aquatic vegetation (SAV) maps and bathymetry derived from the NOAA nautical chart of Barnegat Bay to produce a seamless habitat map for the entire Barnegat Bay ecosystem. The resulting comprehensive synthesis map combined upland, wetland and the benthic habitats of the Barnegat Bay watershed.

Landsat Multispectral Scanner (MSS) data from 1972 and Landsat Thematic Mapper data from 1984 were also mapped by CRSSA and used to establish change analysis trends to assist in measuring development processes and habitat loss within the Barnegat Bay watershed.

VII. B. Integrated Coastal Management (ICM) Tool

The ICM tool is a software program designed to help you make coastal resource management decisions. After you input basic data sets about your area, you can use the tool to quickly generate reports, maps, and data tables. You can also input different scenarios and quickly compare the results.

HIGHLIGHT

The tool calculates habitat statistics that are used to examine how habitats function within a landscape.

The tool calculates habitat statistics that are used to examine how habitats function within a landscape. These statistics allow users to identify and rank components of the landscape and perform land use scenario testing along with optional aquatic habitat calculations and data overlays. Results can be displayed as reports or in an ArcGIS map format.

Sample Functions:

- Inventory habitats
- Assess land and water habitat conditions
- Identify and rank potential restoration and conservation sites
- Analyze "what if" scenarios for proposed changes in land use or land cover
- Create maps, reports, and data tables

The ICM tool was designed with the local planner, the coastal conservation group, and the coastal manager in mind. Altering the scenarios is easy, which gives the user the ability to quickly and easily compare results.

Geographic information systems (GIS) software installed on your computer is required (ESRI® ArcMap 8.3 with Spatial Analyst®), but no in-depth GIS experience is necessary. The required baseline data set is land cover data in a raster format, and other data sets can be added. Data files included with the tool are listed in the following table:

Data Type	Format	Description
Land Cover	Raster	Project Area C-CAP Land Cover Data (2000)
Invasive Species	Shapefile	Michigan Sea Grant Purple Loosestrife - Invasive Species
Shoreline Hardening Structures	Shapefile	NOAA Environmental Sensitivity Index (ESI) Shoreline
Element Occurrences	Shapefile	Michigan Natural Features Inventory Element Occurrences
Streams	Shapefile	Project Area Hydrographic Lines
Boundaries - Political, Geographic	Shapefile	Project Area Boundary
1800's Land Cover	Shapefile	St. Clair, Macomb, and Wayne County 1800's Land Cover
Socioeconomic Growth Forecast	Shapefile	Michigan 2030 Socioeconomic Growth Forecast (SEMCOG)

Data Type	Format	Description
Historic Water Levels	Shapefile	Project Area Historic Water Levels
Soils	Shapefile	Michigan Project Area SSURGO Soils
Land Ownership	Shapefile	Project Area Public Land Ownership
Water Depth	Shapefile	Lake St. Clair DEM
Water Temperature	Shapefile	Great Lakes Water Temperatures - Coastwatch SST
Light Metric	Shapefile	Water Claritiy (Secchi Depth)
Aquatic Invasive Species	Shapefile	Zebra Mussel Location

Terrestrial Analysis

The terrestrial analysis is aimed at assessing quality and connectivity potential from spatial data. The tool is ideally suited to identifying a short list of potential suites that are direct answers to your customized questions. Terrestrial metrics include:

- Nearest neighbor
- Proximity
- Size
- Core area
- Distance to stream
- Presence or absence of a hardened shoreline
- Count of elemental occurrences
- Count of invasive species

The names of the last four metrics may be changed to accommodate different management questions. For instance, distance to stream may be changed to distance to road, or distance to school or any other point of interest. The algorithms or how the scores are calculated are fixed but the names are flexible.

A linear system of user defined scoring has been established that is flexible for each metric. The user defines the best score, best value, worst score, worst value, and the number of divisions between the two. As an example let's look at the distance to stream metric. If the best value is 400 meters and the best score is 3, than any stream distance less than or equal to 400 meters will receive a score of 3. If the worst value is 1600 meters and the worst score is 0, than any distance greater than or equal to 1600 meters will receive a score or 0. If the number of divisions were 4, then the distribution of scores would be 0-400m (score of 3), 401-1000m (score of 2), 1001-1599 (score of 1), 1600m or more (score of 0).

Overlays are data sets that can be added to an analysis without contributing to the score. Terrestrial overlays include:

- Percent natural area
- 1800s land cover
- Soils
- Historic water levels
- Socioeconomic Growth
- Land Ownership

If for instance, you wanted to find high quality area that were located on sandy loam, you could incorporate a soils layer with the analysis so that the soil types associated with each area would be determined. The names of all of the overlays except for percent natural area may be changed to allow for greater flexibility in the tool.

The terrestrial analysis also has a scenario testing component which allows you to make changes to the base land cover data sets and evaluate the impacts of those changes. This feature allows for the evaluation of conservation and restoration decisions as well as growth and development changes.

The NOAA Coastal Services Center's Impervious Surface Analysis Tool (ISAT) has been incorporated into the tool for the terrestrial analysis. You can change the impervious surface coefficients for each land cover type, and receive an impervious percentage for the habitat, non- habitat, and complete analysis areas.

There are four output queries available with the terrestrial analysis: metric, category, total, and aggregate. The metric query is the base query which allows for the evaluating metrics such as size and distance to stream. The category query allows for identifying quality and connectivity scores which are linear combinations of the metrics. The total query is for identify areas with a given total score which is the linear combination of quality and connectivity. The aggregate query provides the ability to combine any of other queries. An individual output record can be generated for each query.

Aquatic Analysis

The aquatic analysis is aimed at assessing physical and biological quality of aquatic habitat from spatial data. The tool is ideally suited to identifying a short list of potential suites that are direct answers to your customized questions. Aquatic metrics include:

- Water Quality
- Depth
- Temperature
- Light penetration (Secchi Disk Depth)
- Invasive species
- Hardened shoreline
- Threatened and endangered species
- Energy exposure
- Sediment quality

The names of all of the metrics except threatened and endangered species may be changed to accommodate different management questions. For instance, distance to temperature may be changed to ice cover, or current velocity or any other parameter of interest. The algorithms or how the scores are calculated are fixed but the names are flexible

A linear system of user defined scoring has been established that is flexible for each metric. The user defines the best score, best value, worst score, worst value, and the number of divisions between the two. As an example let's look at the temperature metric. If the best value is 4 °C and the best score is 3, than any temperature greater than or equal to 4 °C will receive a score of 3. If the worst value is 1 °C and the worst score is 0, than any temperature less than or equal to 1 °C will receive a score or 0. If the number of divisions were 4, then the distribution of scores would be 0-1 °C (score of 0), 2 °C (score of 1), 3°C (score of 2), 4 °C or more (score of 3). The water quality metric is slightly different in that the scoring is entirely user defined for each chemical species of interest. The user first selects the chemical, and then builds a series of logical statements to establish a concentration range and score for that range. The tool then tests each statement in order from top to bottom. The first statement that is found true for the aquatic zone determines the score that will be applied. The tool then proceeds to the next chemical species.

Overlays are data sets that can be added to an analysis without contributing to the score. Aquatic overlays include:

- Substrate
- Biological distribution
- Fish consumption advisory
- Sediment quality

If for instance, you wanted to find an area with a given depth and temperature range that had a gravel substrate, you could incorporate a substrate layer with the analysis so that the substrate types associated with each area would be determined.

There is one query available with the aquatic analysis, a metric query. The metric query is the base query which allows for the evaluating metrics such as temperature and depth. An individual output record can be generated for the query.

Time Saving Features: Existing Projects

A number of time saving features have been built into the tool. The majority of the features deal with the use of existing or previously run projects; however, there are time saving features with starting a new run. A set of default values, scores, project area location, and project classification are loaded into the interface each time a new run is started. A new set of defaults can also be created and saved. The output from an existing project can be loaded back into the main interface, so that new maps can be generated, tables viewed, and reports exported. The settings from an existing project can be loaded back into the interface. This allows for subtle modification of a project without starting over, previously loaded data sets are brought back into the tool as well as the analysis area, habitat classification, scores, queries, overlays, and scenario testing parameters. A previously generated patch file and a parameters file can also be loaded into the tool. A patch file is an ArcGIS® shapefile that contains all of the output from a previous project and a parameters file is an .ini file containing the setup information for the project. The input data, the analysis area, and the habitat classification setting are fixed with this option however; scores, queries, overlays and scenario testing can all be quickly re-calculated. This option essentially allows you to come into a project 2/3 of the way done with modifications.

Parameter Sensitivity and Uncertainty: Batch Projects

Batch projects offer the capability to test a range of parameters to see which are the most sensitive or suitable to your problem or area. It is often difficult to pick values, scores, buffer distances, habitat classifications, and to site locations for restoration or development. This component allows for the testing of multiple scores and values within one project run. Multiple buffer distances can be evaluated to see which distances return the most meaningful information. The choice of habitat classification scheme can have an enormous impact on the output, so it is included as a batch choice. The user can evaluate the consequences of a simple versus unique scheme or two simple schemes, one without grassland. Multiple types of changes to land cover can be evaluated at one time by setting up a batch scenario testing run. Batch projects can be done with either new or existing projects.

VII. C. Potential Conservation Area Analysis

Natural resource conservation is a fundamental component of a community's long-term environmental and economic health. Natural resource areas perform important natural functions such as water filtration and provide recreational opportunities and wildlife habitat that enhance the overall vitality of a community. Abundant natural resources once surrounded population centers in the area. Now, much reduced in size, natural resource areas are becoming encircled by development. These remaining sites are the foundation of Lake St. Clair's natural heritage; they represent the last remaining remnants of the area's native ecosystems, natural plant communities and scenic qualities. Consequently, it is to a community's advantage that these sites be carefully integrated into the planning for future development. Striking a balance between development and natural resource conservation and preservation is critical if Lake St. Clair is to maintain its unique natural heritage. This approach will provide the greatest opportunity to maintain high property values and continued market demand. Part of what makes the Lake St. Clair such a unique and desirable place to work, live and recreate is the quality and accessibility of its natural landscapes, lakes, rivers and streams.

HIGHLIGHT

Abundant natural resources once surrounded population centers in the area but now they are being surrounded by development.

Successful land use planning requires more than simply protecting small preserves and trusting that they will remain in their current condition indefinitely. Many human activities such as road construction, chemical and fertilizer application, fire suppression and residential development can have a detrimental impact on populations of plants, animals and insects and the natural communities in which they live. Changes in zoning, building codes and technology can cause areas that were once considered "safe" from development to be exposed to development. In order to maintain the integrity of the most fragile natural areas, a more holistic approach to resource conservation must be taken, an approach that looks beyond the borders of the site itself. What happens on adjacent farmland, in a nearby town or upstream should be considered equally as important as what happens within a preserve. By looking to the past, understanding the present and considering the future, it becomes apparent that a balance must be struck between development and natural resource preservation.

FACT
Successful land use planning requires more than simply protecting small preserves and trusting that they will remain in their current condition indefinitely.

The process established by the Michigan Natural Features Inventory (MNFI) to initially identify Potential Conservation Areas (PCAs) for this project can also be used to update and track the status of these remaining sites, as more information becomes available. In addition to the presence of native vegetation, factors including the size and shape of a particular parcel of land, presence or absence of a water body, spatial relationship to other natural areas, vegetation quality, restorability of surrounding lands and biodiversity value are used to identify and rank PCAs. The Integrated Coastal Management Tool (See Section VII. B.) allows planners to replicate this process easily as conditions change.

FACT
Element occurrences are verified sightings of threatened, endangered or special concern species and high quality natural.

Element occurrences (EO) - known and verified sightings of threatened, endangered or special concern species and high quality natural communities are tracked by MNFI in Michigan and the Natural Heritage Information Centre (NHIC) in Ontario. Element occurrences are often, although not always, indicative of the quality of a site, but the occurrences in and of themselves are important. Disclosure of information on the precise locations of sensitive species, however, is problematic and can lead to accidental or deliberate harm to the species. In order to eliminate this risk, the information on Element Occurrences is incorporated into models which take the sensitive species information and put it into a form that is easy to incorporate into planning processes, while not revealing precise information on locations.

VII. C. 1. Element Occurrence Models

Element occurrences - verified records of listed species, high quality natural areas or other natural features of interest around Lake St. Clair were used to create three element occurrence models as part of the potential conservation area analysis for the project:

- an element occurrence frequency count,
- an element occurrence probability model and
- a biodiversity value model

As discussed earlier in Sections VI. B. 2. and VI. B. 3., Michigan Natural Features Inventory (MNFI) and the Natural Heritage Information Centre (NHIC) in Ontario maintain natural heritage databases of known and verified sightings

of threatened, endangered, or special concern species and high quality natural communities. MNFI and NHIC data are entered into their respective databases using the Natural Heritage methodology originally designed by The Nature Conservancy and now maintained by NatureServe (*www.natureserve.org*). To be able to uniformly assess biodiversity values across the different political jurisdictions, only those species tracked in common by both MNFI and NHIC were considered in the analysis.

FACT

Element Occurrence Models take sensitive species information and put it into a form that is easy to incorporate into planning processes, while not revealing precise information on locations.

The element occurrence frequency count consists of the number of known element occurrences in any given area. The element occurrence probability model is intended to highlight those areas with known occurrences of rare species or high quality natural communities. The biodiversity value model is intended to help prioritize those areas for conservation. The models are at the Public Land Survey System (PLSS) section resolution (~ one square mile). No PLSS boundaries existed for the Canadian side of the project area. To have a uniform system for the analysis, the PLSS lines from Michigan were extended to the Canadian side.

VII. C. 1. a. Methodology

Prior to GIS, each record of a species occurrence was mapped on USGS 7.5 minute quadrangle maps. A dot was placed on the map at the estimated latitude/longitude center of the occurrence location and the latitude/longitude recorded in the database. Each record was also given a mapping precision based on the known location. Second precision records meant the location was known precisely. Minute precision records were known to occur within a mile and a half of the lat/long point. General precision records were known to the township or quadrangle name level.

With the advent of GIS, the MNFI database was ported into a GIS. The mapping precision was used to give each occurrence a spatial extent. Second precision records were given a 100 meter buffer, minute precision records were given a 2,000 meter buffer and general records were given an 8,000 meter buffer. Newer records are entered as polygons with a digitized spatial extent. Occurrences best represented by a point, (i.e. small plant populations or nest sites) are represented by a small (12 meter) polygon. As part of this project, MNFI records in the project area were examined for both their spatial extent and a review of their rankings. Where appropriate, the spatial extent was digitized using natural heritage methodology.

Under heritage methodology, only the known spatial extent of an occurrence is recorded. For example, if the known location for a species is only reported as being within a given section, then that section boundary become the spatial extent of the occurrence. All natural communities were given defined spatial extents. The NHIC data came in the form of a lat/long point with a mapping uncertainty. The spatial extent of the NHIC data was defined by using the mapping uncertainty as a buffer to create a polygon.

The modeling process starts by grouping species into habitat guilds and assigning a habitat identifier code to each species occurrence in the database. Next a habitat layer is created for each habitat guild. Habitat layers are often created as ESRI ArcINFO grids and then converted to ESRI shapefile format. The habitat layers are then used to redefine the spatial extent of the occurrences. This is accomplished by selecting all the occurrences with a given habitat code and then clipping the selected occurrences using the appropriate habitat layer as the clipping overlay theme. The result of this operation produces a new theme for each habitat group. In each new theme the spatial extent of each occurrence is replaced by the spatial extent of the habitat within the original boundary of the occurrence. The new theme retains all the database attributes of the original occurrence database. Where fragmented habitat patches occur within an occurrence boundary, the occurrence will be converted from a single shape to multiple shapes.

The clipping operation was not performed on natural community occurrences because the communities have a defined spatial extent. The natural communities are selected out of the occurrence database and converted to a separate layer. The themes for each habitat group and the natural community themes are then all merged together. After merging the themes for each habitat type into a single theme, the merged theme is dissolved on the unique code number assigned to each individual occurrence. This operation consolidates all the separate shapes for each occurrence into a single shape for each occurrence.

Each occurrence is then assigned a value based on the age of the record. This value is used to represent the likelihood of the occurrence still existing. Occurrences with a last observed date of no later than 1982 are assigned a value of one, occurrences between 1970 and 1982 are assigned a value of 0.5 and occurrences prior to 1972 are assigned a value of 0.25. All natural community records are assigned a value of one.

Each occurrence is also assigned three other values, one based on the species global status (Global or G rank), one based on the species State status (sub-national or S rank) and one based on the occurrence quality (viability) rank (EO rank). The greater the threat of imperilment to the species, the higher the value assigned to the occurrence. In a similar manner, the higher the quality of each occurrence, the higher the value it is given. The conservation value of each occurrence is then calculated by adding the values for the global status, state status and the quality ranking and then multiplying the sum by the age based value. The values for each rank are shown below in Table VII C 1 a - 1.

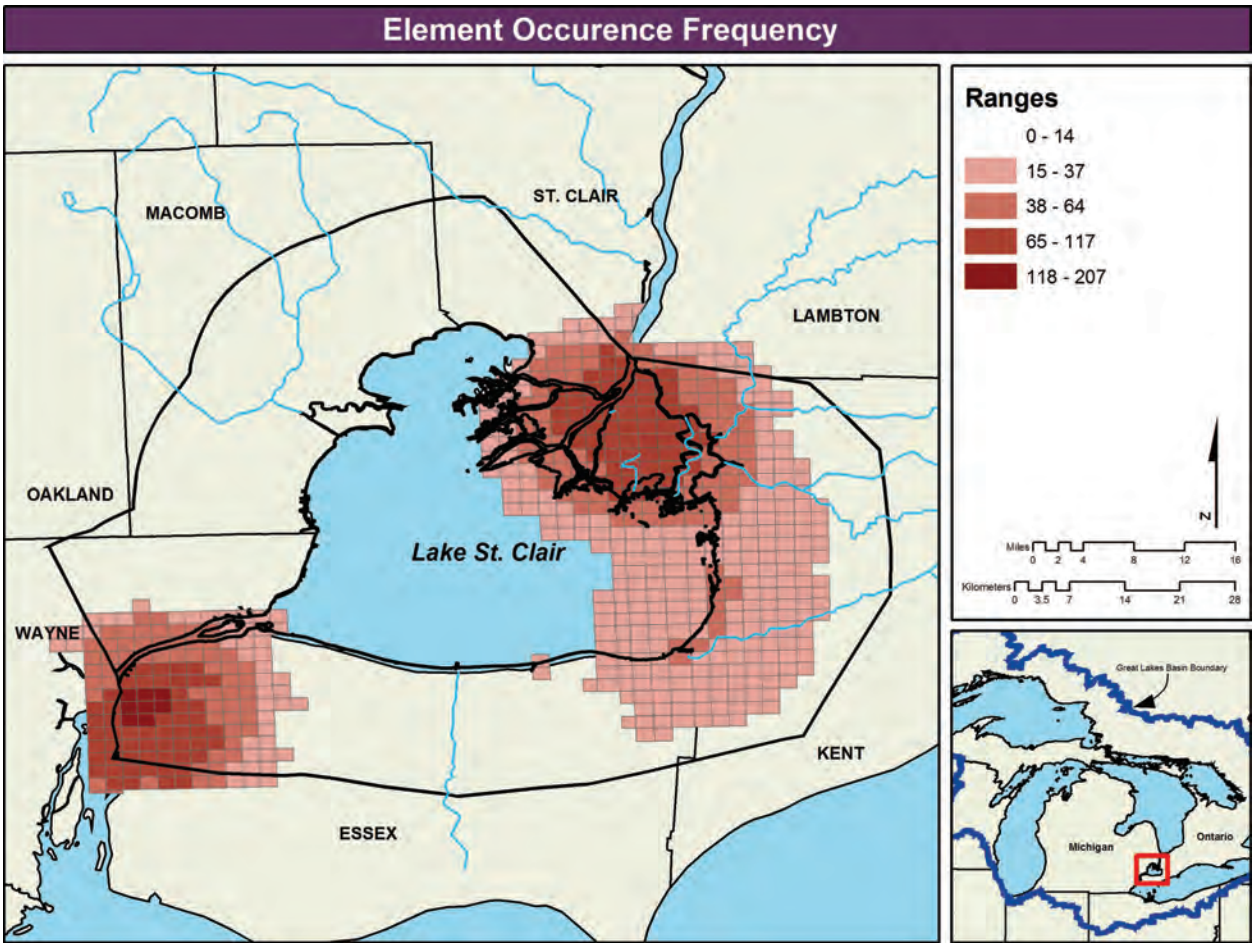


Figure VII C 1 b -1

Table VII C 1 a -1

Values Assigned for Species' Global and State Ranks and Element Occurrence Ranks					
Global Rank	Score	State Rank	Score	Occurrence Rank	Score
G1	10	S1	5	A	5
G2	6	S2	4	B	4
G3	3.5	S3	3	C	3
G4	2	S4	2	D	2
G5	1	S5	1	E	1
U	1	SU	1	U	2
				No Rank	2

VII. C. 1. b. Element occurrence frequency

The frequency count shows where there are concentrations of occurrences. It is based on the known extents of documented occurrences but does not consider the availability of habitat within the occurrence boundaries.

Element occurrence frequency counts in the 1803 sections ran from a count of zero in 253 sections (approximately 14 %) to over 100 occurrences in 13 sections (less than one percent). One section had a count of 207 occurrences (See Table VII C 1 b – 1).

Table VII C 1 b -1, EO Frequency Count Results

Number of occurrences per PLSS section		
Frequency classes	Number of sections	Percentage of total sections
0	253	14.0%
1 - 5	581	32.2%
6 - 10	296	16.4%
11 - 15	91	5.0%
16 - 20	65	3.6%
21 - 25	80	4.4%
26 - 30	77	4.3%
31 - 35	57	3.2%
36 - 40	43	2.4%
41 - 45	38	2.1%
46 - 50	23	1.3%
51 - 55	25	1.4%
56 - 60	30	1.7%
61 - 65	19	1.1%
66 - 70	26	1.4%
71 - 75	22	1.2%
76 - 80	21	1.2%
81 - 85	24	1.3%
86 - 90	9	0.5%
91 - 95	3	0.2%
96 - 100	7	0.4%
> 100	13	0.7%
Total	**1803**	

VII. C. 1. c. Element occurrence probability model

The probability model represents the probability of encountering a sensitive species in any given unit (section, quarter section, quarter-quarter section). The probability value is based on known sightings of sensitive species, the availability of appropriate habitat within an area and the age of the sensitive species record. The value "No Status" indicates there is no knowledge of a species in that particular unit or there is no appropriate habitat left for a species that may have been present. The value "Low" means that there is a known record of a sensitive species but the record is older than 1970. The value of "High" indicates there is a known record of a sensitive species since 1982 and there is still appropriate habitat for that species. A value of "Moderate indicates there is a known species record recorded between 1970 and 1982. The probability value in any given unit reflects the highest known probability. Any given unit may have more than one species and probability value possible, but only the highest probability value is used.

To create the probability value for the PLSS data set, all records in the PLSS data set are selected and assigned a "No Status" value. Next the records in the species database with the lowest probability of still existing (value = 0.25) are selected. The PLSS data set

Table VII C 1 c -1, EO Probability Model Results

Probability of an occurrence in a PLSS section		
Probability	**Number**	**Percentage**
High	706	39.2%
Moderate	95	5.3%
Low	361	20.0%
No Status	641	35.6%
Total	**1803**	

is intersected with the species database and the selected PLSS records are assigned a value of "Low." Next those records with a moderate likelihood of still existing are selected (value = 0.5). The PLSS data set is intersected with the species database and the selected PLSS records are assigned a value of "Moderate." Finally the records in the species database with the highest probability of still existing (value = 1) are selected. The PLSS data set is intersected with the species database and the selected PLSS records are assigned a value of "High." Performing the selections and intersections in this order insures that a higher probability in any PLSS feature will override a lower probability.

There are a total of 1803 PLSS sections intersecting the project boundary (See Table VII C 1 c -1). Approximately 39% of the sections have a high probability of a rare species occurrence. Approximately 5% have a moderate probability and approximately 20% have a low probability. Approximately 36% have no known occurrences or no habitat within the know extent of existing occurrences.

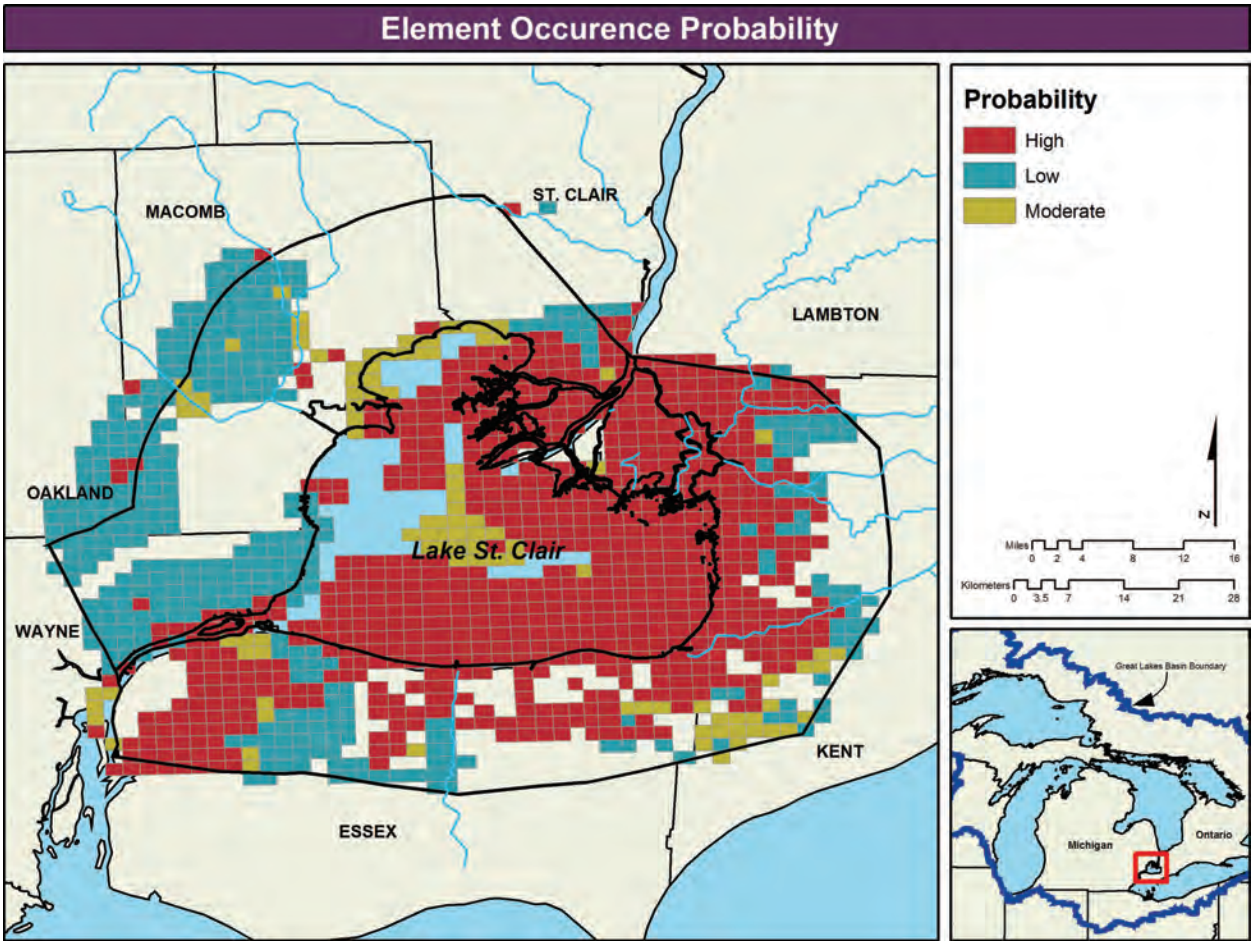


Figure VII C 1 c -1

VII. C. 1. d. Biodiversity value model

The biodiversity value model is an index of the biodiversity value for each particular unit. This index reflects the relative biodiversity value of that particular unit. The factors used to calculate the biodiversity index include the species

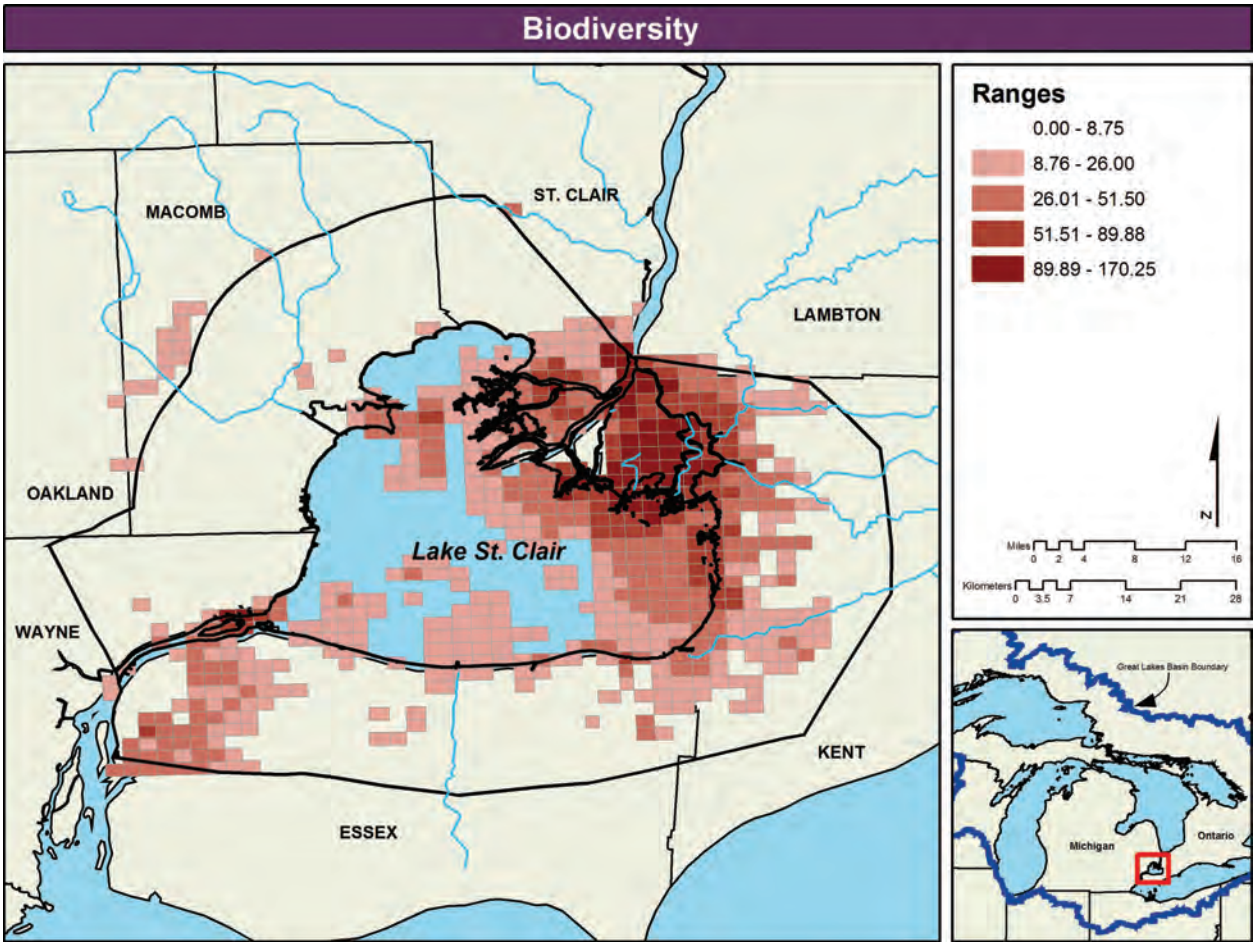


Figure VII C 1 d -1

Table VII C 1 d -1, EO Biodiversity Value Model Results

Biodiversity values for PLSS sections		
Biodiversity value	Number of PLSS sections	Percentage
0.00	641	35.6%
0.01 - 10.00	613	34.0%
10.01 - 20.00	166	9.2%
20.01 - 30.00	139	7.7%
30.01 - 40.00	66	3.7%
40.01 - 50.00	49	2.7%
50.01 - 60.00	35	1.9%
60.01 - 70.00	22	1.2%
70.01 - 80.00	6	0.3%
80.01 - 90.00	17	0.9%
90.01 - 100.00	9	0.5%
> 100.01	40	2.2%
Total	**1803**	

global imperilment, state imperilment, the viability of each occurrence and the age of the occurrence. The index is an open ended value and the higher the value, the greater the biodiversity value of the unit. The index allows users to weigh the relative biodiversity value of different units. It is not designed to be used as an absolute value where a score of twenty five is good and a score of fifteen is not good. It merely means that the unit with a score of twenty five has more known biodiversity values that the one with a score of fifteen.

To calculate the biodiversity index for a given PLSS feature, each feature in the PLSS theme is selected in sequence. After a PLSS feature is selected all the species occurrences intersecting the PLSS feature are selected. Then the conservation values of the selected species occurrences are summed and assigned to the PLSS feature. The result is a value for each PLSS unit that is the sum of conservation values of all occurrences falling within the PLSS unit.

The biodiversity rankings for PLSS sections within the project area ranged from zero to a high of 170.25 (See Table VII C 1 d -1).Of the 1803 PLSS sections in the project area, 641 (approximately 36%) had a biodiversity ranking of zero. Forty sections (approximately two percent of the total) had a score over 100. To put the biodiversity value in perspective, a section with one highly viable (A ranked) occurrence of a globally rare species (G1 species) that is also rare in the State (S1 species) and has been seen since 1982 would have a score of 20 (ten points for G1 + five points for S1 + five points for A rank times one). The same occurrence that was last seen between 1970 and 1982 would have a score of 10 (ten points for G1 + five points for S1 + five points for A rank times one-half).

One must take care to not misinterpret the biodiversity value. The biodiversity value model is based on known occurrences of rare species. The ranking of zero indicates there is no record of a rare species, or habitat within the extent of a known occurrence, within the PLSS section. A value of zero means that there is no value in terms of rare species, however, that does not mean that any given section has no biodiversity value.

VII. C. 2. Potential Conservation Areas

The Michigan Natural Features Inventory (MNFI) identified and ranked Potential Conservation Areas (PCAs) remaining in a 10 mile buffer area around Lake St. Clair area. PCAs are defined as places on the landscape dominated by native vegetation that have various levels of potential for harboring high quality natural areas and unique natural features. In addition these areas may provide critical ecological services such as maintaining water quality and quantity, soil development and stabilization, pollination of cropland, wildlife travel corridors, stopover sites for migratory birds, sources of genetic diversity and floodwater retention. However, the actual ecological value of these areas can only be truly ascertained through on the ground biological surveys.

HIGHLIGHT

The actual ecological value of remaining natural areas can only be truly ascertained through on the ground biological surveys.

The process established by MNFI to identify potential conservation areas, can also be used to update and track the status of these remaining sites. MNFI recommends that local municipalities in Ontario, Michigan and Walpole Island First Nation incorporate this information into their comprehensive natural area mapping services. The site map and ranking data can be used by local municipalities, land trusts and other agencies to prioritize conservation efforts and assist in finding opportunities to establish an open space system of linked natural areas along Lake St. Clair.

VII. C. 2. a. Process for delineating and ranking potential conservation/natural areas

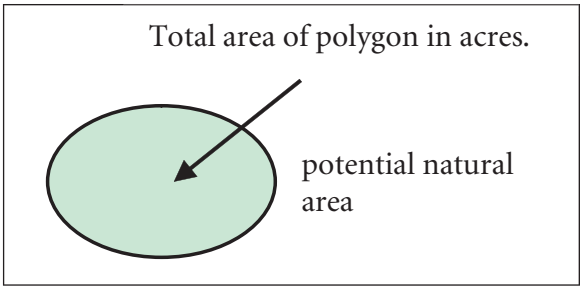
Interpretation of the 10 mile buffer area around Lake St. Clair was conducted by using a C-CAP satellite imagery data set which was taken in 2000. Land coverages were divided into natural and cultural types. All natural land cover types were lumped and converted into a shapefile. The major and minor road data layers were used to split polygons into additional polygons. An additional layer, named the coastal transition zone, was created so that shoreline sites and islands were not penalized for low connectivity. Municipal boundaries were not utilized to delineate site boundaries unless the boundary corresponded to a defined hard edge, such as a road. In addition, due to the 30 x 30 meter pixel size, non-natural lands that totaled four pixels or less in size and were completely contained within the PCA, were integrated into the PCA. Once all sites were delineated, sites under 20 acres were removed from the shapefile.

Site Selection and Prioritization

Following the delineation of PCAs, a more rigorous level of examination was undertaken based upon specific scaled criteria to prioritize sites. The criteria used to first delineate the sites were translated to a numerical scale. Each site could then be assessed based upon the scaled criteria and a total calculated score, based upon the sum of the scores for each criterion.

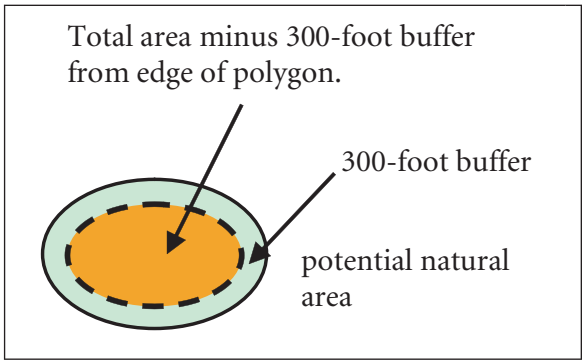
Description of Criteria

Total Size - The total size of a site is recognized as an important factor for viability of species and ecosystem health. Larger sites tend to have higher species diversity, higher reproductive success and improve the chances of plant and animal species surviving a catastrophic event such as a fire, tornado, ice storm, or flood.



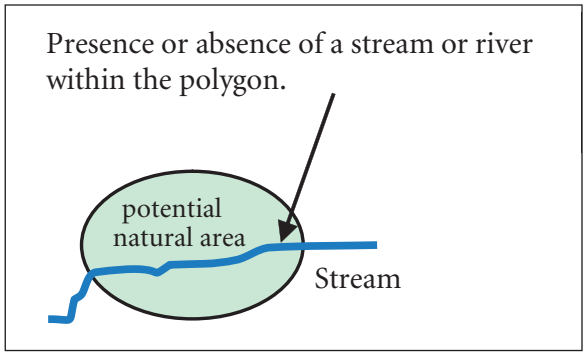
Size is defined as the total area of the polygon.

Size of Core Area - Many studies have shown that there are negative impacts associated with the perimeter of a site on "edge-sensitive" animal species, particularly amphibians, reptiles and forest and grassland songbirds. Buffers vary by species, community type and location, however most studies recommend a buffer somewhere between 200 and 600 ft. to minimize negative impacts. Three hundred feet is considered a sufficient buffer for most "edge-sensitive" species in forested landscapes.



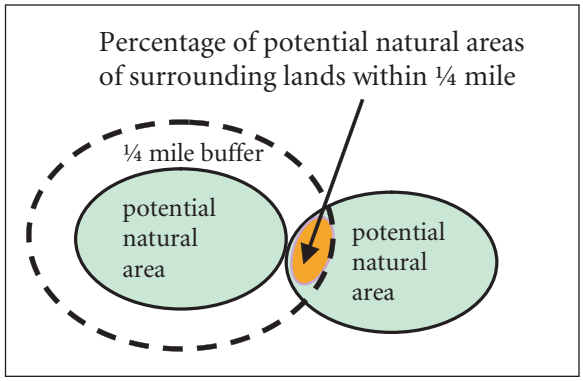
For this project, core area is defined as "size" (see above) minus a 300-foot wide buffer measured inward from the edge of the polygon. Core area is different from total area of the site because it takes into account the shape of the site. Typically, round shapes contain a larger core area relative to the total site than long narrow shapes.

Stream Corridor (presence/absence) – Water is essential for life. Streams are also dynamic systems that interact with the surrounding terrestrial landscape creating new habitats. Waterways also provide the added benefit of a travel corridor for wildlife, connecting isolated patches of natural vegetation.



Sites that are part of riparian corridors were given a score of 2 points if the site included a portion of a river or stream system or 0 points if it did not.

Landscape Connectivity – Connectivity between habitat patches is considered a critical factor for wildlife health. High connectivity improves gene flow between populations, allows species to recolonize unoccupied habitat, improves resilience of the ecosystem and allows ecological processes, such as flooding, fire and pollination to occur at a more natural rate and scale. Landscape connectivity was measured in two ways, percentage and proximity.



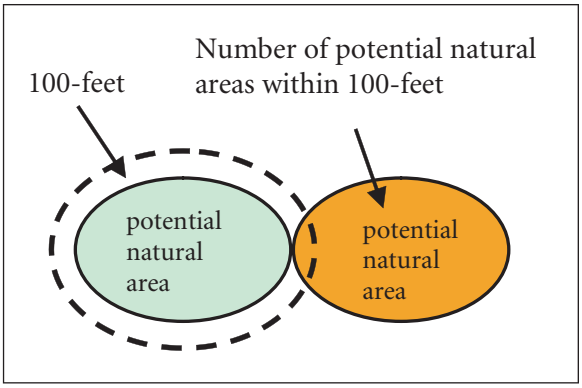
Percentage

Landscape connectivity was measured by building a ¼ mile buffer around each polygon and measuring the percentage of area that falls within other potential conservation areas.

Proximity

In addition to measuring the area around a polygon that is considered natural, connectivity can also be mea-

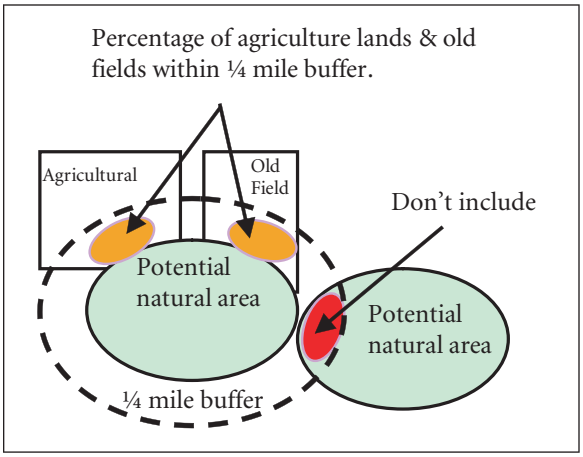
sured by the number of individual potential conservation areas in close proximity to the site. The greater the number of polygons in "close proximity," the higher the probability for good connectivity. Close proximity was determined to be 100 feet. One hundred feet was chosen as the threshold based on digitizing error and typical width of transportation right-of-ways, pipelines and powerline corridors.



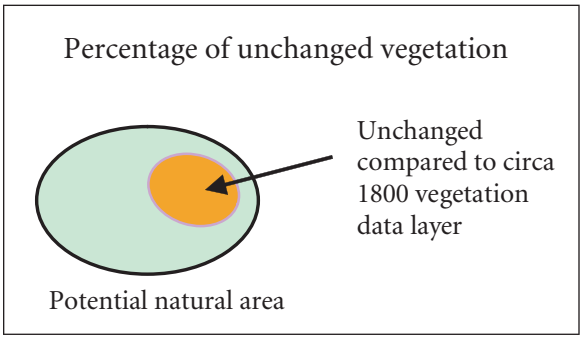
Note: A marsh transition zone was developed as a surrogate for PCAs to help measure connectivity values for sites adjacent to Lake St. Clair. This zone was defined by the record high water mark and record low water mark plus six vertical feet out into the lake. Without the transition zone, sites adjacent to Lake St. Clair were awarded lower connectivity scores because only terrestrial land was considered for PCA delineation.

Restorability of Surrounding Lands – Restorability is important for increasing the size of existing natural communities, providing linkages to other habitat patches and providing a natural buffer from development and human activities.

Restorability is measured by the potential for restoration activities in areas adjacent to the delineated site. First, a ¼ mile buffer was built around each site. Potential conservation areas as defined by MNFI, located within the buffer area were then removed and the percentage of agricultural land and old fields within the remaining buffer area was measured. Only agricultural land and old fields were considered because they require the least amount of effort to restore back to some sort of natural condition.

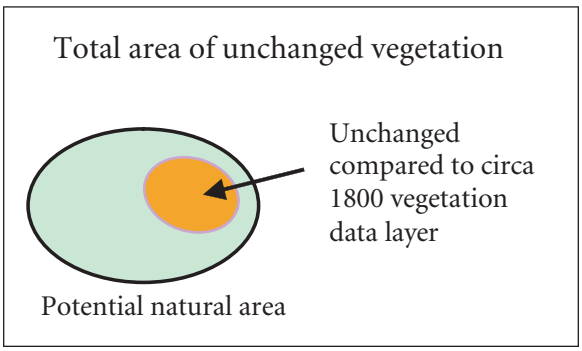


Vegetation Quality – The quality of vegetation is critical in determining the quality of a natural area. Vegetation can reflect past disturbance, external impacts, soil texture, moisture gradient, aspect and geology. Vegetative quality however is very difficult to measure without recent field information. As a surrogate to field surveys, a vegetation change map comparing the 2000 IFMAP landcover data layer to the circa 1800 vegetation data layer was created. The resulting potential unchanged vegetation can then act as an indicator of vegetation quality.



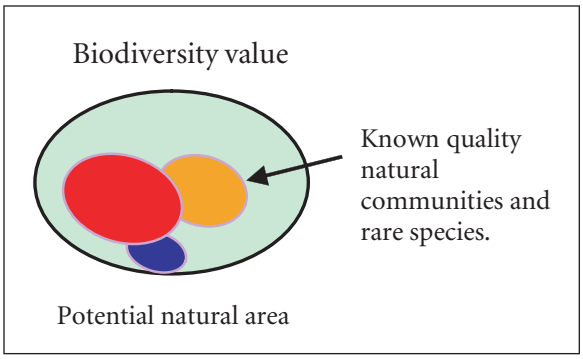
Percentage

Vegetation quality was measured by calculating the percentage of the site that contains potentially unchanged vegetation. This allows small sites with a high percentage of potentially unchanged vegetation to score points.



Area

Vegetation quality was also measured by calculating the area of potentially unchanged vegetation that falls within each site. This balances the bias of small sites with high percentage of potentially unchanged vegetation by awarding points based on actual area covered.



Biodiversity Value – The location of quality natural communities and rare species tracked by MNFI are often, although not always, indicative of the quality of a site. The occurrences in and of themselves are important.

The Biodiversity value is based on the cumulative score of each element occurrence (EO) found within a site. Each EO is scored based on its probability of being found, global rarity, state rarity and condition or viability. For example, a much higher score would be awarded to a population of Mitchell's satyr, which is globally and state imperiled, that is in good condition, compared to a population of box turtles, which is globally secure and rare in the state, that is in fair condition.

Note: The number of points assigned for each criterion is in the site criteria table on page 13.

VII. C. 2. b. Priority rankings for Michigan

In total, there were 386 potential conservation areas identified on the Michigan side of the study area. Total scores ranged from 28 points (out of a possible 37) to a low of 1 point. The average score was 9. Once the total scores were tabulated, the next step was to determine a logical and reasonable break between priority one, priority two and priority three sites. Many potential conservation area sites can be just one point away from being placed into another category.

FACT

386 potential conservation areas identified on the Michigan side of the study area.

To determine where the breaks between categories should occur, the natural break classification (or Jenk's optimization), which is the default classification method in ArcView, was used. This method identifies breakpoints between classes using a statistical formula called Jenk's optimization. The Jenk's method finds groupings and patterns inherent in the data by minimizing the sum of the variance within each of the classes.

Despite this objective methodical approach to classification, it still could be argued that sites scoring one point below should be included in the higher category or that sites scoring right at the low end of a category should be placed in the next lowest category. To help alleviate anxieties about which category a particular site is placed, actual numeric total scores can be displayed in the middle of each polygon. This would allow the viewer to see how a site compares directly to another site without artificially categorizing it within a group.

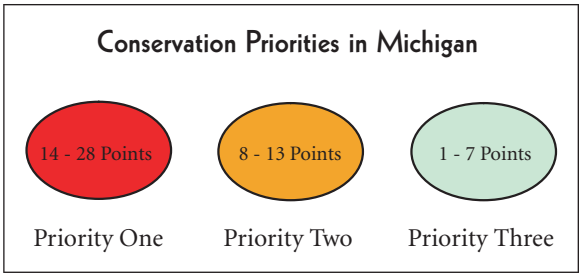
HIGHLIGHT

In Michigan, the three highest ranking sites were St. John's marsh, Algonac State Park and Dickinson Island.

Using the natural break classification, a total of 145 sites were placed in the priority three category, 197 sites were placed in the priority two category and 44 sites were placed in the priority one category. Breaking it down into percentages of total sites identified, 37.6% were labeled priority three, 51.1% were labeled priority two and 11.3% of the sites were identified as priority one. It is important to note that although only 11.3%

of the sites were identified as priority one, these 44 sites total 18,720 acres. This corresponds to 42% of the total acreage of all delineated sites (44,143 acres).

The three sites with the highest scores were St. John's marsh, Algonac State Park and Dickinson Island. Only one site, St. John's marsh, received the highest score of 28. The largest site on the Michigan side is Dickinson Island at 2,698 acres.



VII. C. 2. c. Priority rankings for Ontario

In total, there were 161 potential conservation areas identified on the Ontario side of the study area. Total scores ranged from 24 points (out of a possible 29) to a low of 1 point. The average score was 7.

HIGHLIGHT

Two of the highest ranking Ontario sites were on Walpole Island and the third includes the St. Clair Nation Wildlife Refuge.

Using the natural break classification, a total of 84 sites were placed in the priority three category, 58 sites were placed in the priority two category and 19 sites were placed in the priority one category (see map on page 10). Breaking it down into percentages of total sites identified, 52.2 % were labeled priority three, 36% were labeled priority two and 11.8 % of the sites were identified as priority one. It is important to note that although only 11.8 % of the sites were identified as priority one, these 19 sites total 27,522 acres. This corresponds to 78 % of the total acreage of all delineated sites (35,257 acres).

Three sites received the highest score of 24 points. Two of these sites are located in the middle of Walpole Island and one is located in a coastal marsh just north of the Thames River. An additional three sites on Walpole Island received the second highest score of 23 points. The largest site on the Ontario side (as well as the entire study area) is the Great Lakes marsh complex located in the southern portion of the Walpole Island. It totals 11,366 acres in size or approximately 17.75 square miles.

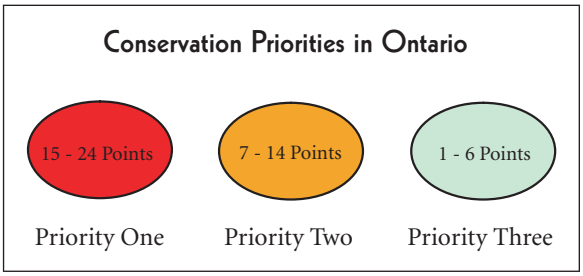


Table VII C 2 c - 1, Site Criteria

Criteria	Description	Detail	Pts
Total Size	Total size of the polygon in acres. ❑ *Size is recognized as an important factor for viability of species and ecosystems.*	20 - 40 ac.	0
		>40 - 80 ac.	1
		>80 - 240 ac.	2
		>240 ac.	4
Size of Core area	Acres of core area. - Defined as total area minus 300 ft. buffer from edge of polygon. ❑ *Greater core area limits negative impacts on "edge-sensitive" animal species.*	0 - 60ac	0
		>60 - 120 ac	2
		>120 - 230 ac	4
		>230 ac	8

Stream Corridor (presence/absence)	Presence/absence of a stream or river within the polygon. ❑ *Stream corridors provide wildlife connections between patches of habitat.*	none	0
		present	2
Landscape Connectivity **Percentage**	Percentage of potential conservation areas within 1/4 mile. - build 1/4 mile buffer - measure % of buffer that is a potential conservation area	0 - 11%	0
		>11 - 22%	2
		>22 - 33%	3
		>33%	4
Proximity	Number of potential conservation areas within 100 ft.. ❑ *Connectivity between habitat patches is considered a critical factor for wildlife health.*	0	0
		1	1
		2	2
		3	3
		4+	4
Restorability of surrounding lands	Restorability of surrounding lands within 1/4 mi. - build 1/4 mile buffer - subtract potential conservation areas from buffer - measure % agricultural lands and old fields ❑ *Restorability is important for increasing size of existing natural communities, providing linkages to other habitat patches and providing a natural buffer from development.*	0 - 35%	1
		>35 - 65%	2
		>65%	3

Criteria	Description	Detail	Pts
Vegetation Quality (Michigan only) **Percentage**	Estimates the quality of vegetation based on circa 1800 vegetation maps and 2000 IFMAP landcover data (only done for Michigan sites). Measures the percentage of potentially unchanged vegetation within a polygon.	1 - 10%	0
		10.1 -30%	1
		30.1 – 65%	2
		65.1 – 100%	4
Area	Measures the actual area within a polygon of potentially unchanged vegetation regardless of the size of the polygon. ❑ *The quality of vegetation is critical to determining the quality of a natural area.*	0 – 10ac	0
		10.1 – 40ac	1
		40.1 – 80ac	2
		80.1 - 160	3
		> 160ac	4
Biodiversity Value (Michigan)	Known element occurrences increase the significance of a site. ❑ *The location of quality natural communities and rare species tracked by MNFI are often, although not always, indicative of the quality of a site.* ❑ *Values were determined using the Jenk's optimization formula. Michigan and Ontario had different ranges.*	0 – 6.99	0
		7 – 23.12	1
		23.13 -52.37	2
		52.38 -96.99	3
		≥ 97	4
Biodiversity Value (Ontario)	Known element occurrences increase the significance of a site. ❑ *The location of quality natural communities and rare species tracked by MNFI are often, although not always, indicative of the quality of a site.* ❑ *Values were determined using the Jenk's optimization formula. Michigan and Ontario had different ranges.*	0 – 13.99	0
		14 - 44.24	1
		44.25-69.99	2
		70-103.24	3
		≥ 103.25	4
Note	Total possible points = 37 for Michigan		
	Total possible points = 29 for Ontario		

VII. C. 2. d. Potential conservation areas map and recommendations

This inventory documents that the area immediately surrounding Lake St. Clair still contains high quality natural resource areas that still look and function the way they did 200 years ago. This is particularly true around the St. Clair flats area at the mouth of the St. Clair River. Not surprisingly, the three highest scoring sites in Michigan are Algonac State Park, St. John's marsh and Dickinson Island, while five of the six highest scoring sites in Ontario are located on Walpole Island. A total of 547 PCAs were identified and ranked in the study area (386 in Michigan and 161 in Ontario). These sites represent what appear to be the least disturbed natural areas remaining within the 10 mile buffer surrounding Lake St. Clair. Together, these 547 PCAs total 79,436 acres, representing approximately 10.5% of the total study area (752,555 acres - terrestrial only).

HIGHLIGHT

On both sides of the international border, the highest ranking sites occur on the St. Clair delta, where high quality natural resources still look and function as they did 200 years ago.

Some of these sites have the potential of harboring endangered, threatened, or special concern animal and plant species. With the high rate of development and its associated stresses on the natural environment, conservation of these remaining areas and their native plant and animal populations are vital if the diverse natural heritage around Lake St. Clair is to be maintained.

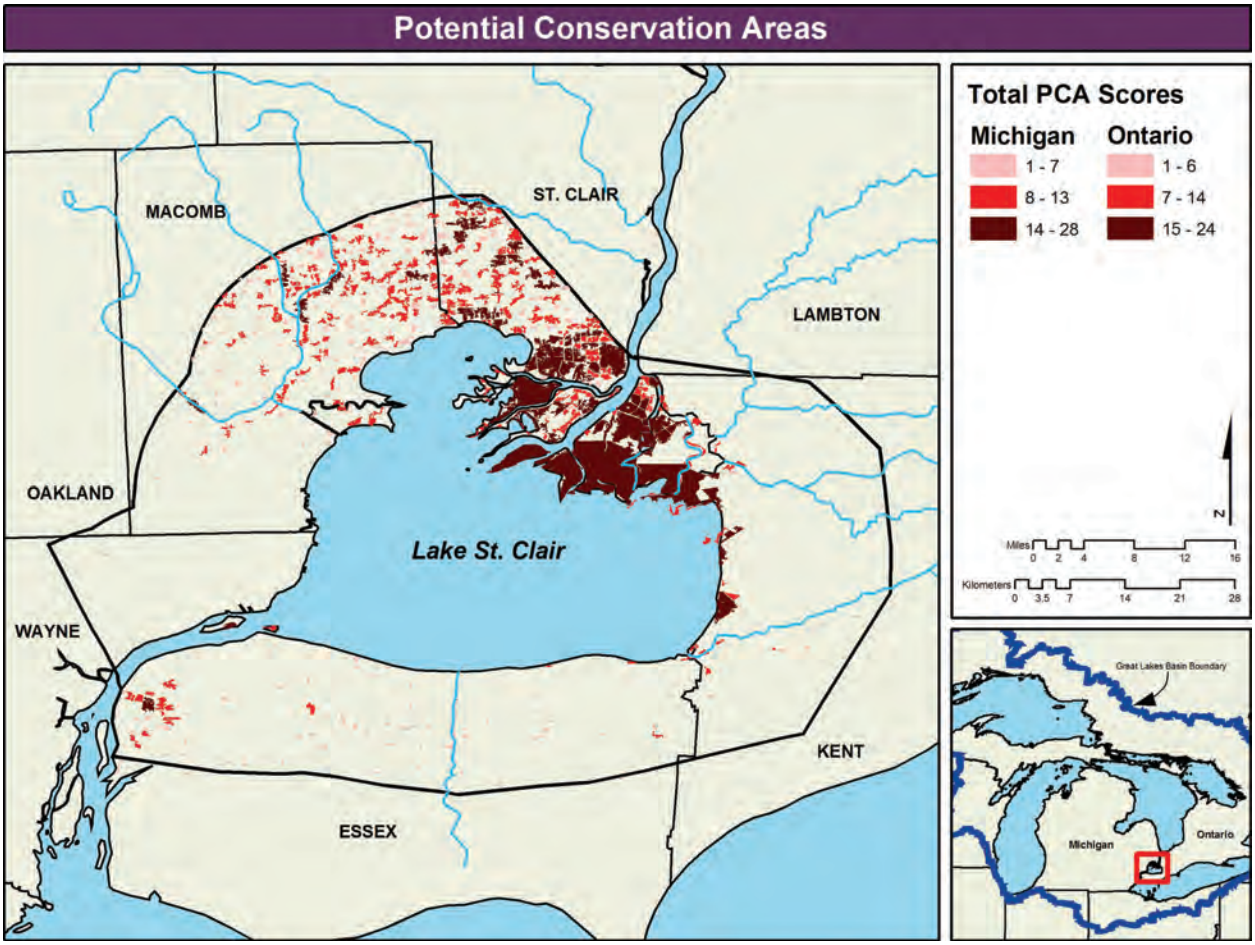


Figure VII C 2 d -1

When using this information it is important to keep in mind that site boundaries and rankings are a starting point and tend to be somewhat general in nature. Consequently, each community, group or individual using this information should determine what additional expertise is needed in order to establish more exact boundaries and the most appropriate conservation efforts.

Tools For Field Inventories

Floristic Quality Assessment was developed by a group a scientists to help field naturalists assess the quality of a natural area. It gives a score for each plant found within the Michigan. Scores range from zero to 10, with zero given to an invasive, non-native species and 10 given to a native species with a high fidelity to a particular type of habitat such as lakeplain prairie. A site can then be ranked by identifying all the plant species located within the site and using the formula provided in the floristic quality assessment[i].

The **Index of Biotic Integrity** (IBI) is a multi-metric approach (the Index of Biological Integrity or IBI) that combined a series of metrics (biological descriptors) to characterize biological condition with fish assemblage data from streams of the Midwestern U. S. There have been numerous adaptations of the approach using different groups of organisms and calibrated for different geographic areas and waterbody types[ii] (Southerland and Stribling 1995, Davis et al. 1996, U.S. EPA 1997). Biological monitoring is based on the premise that biological communities are shaped by the long-term conditions of their environment and more accurately reflect the health of an ecosystem. Each site sampled is scored based on its deviation from reference conditions (i.e. what would be found in an unimpacted stream) and classified as poor, fair, good or excellent.

Recommendations

1) Local units of government, individuals and interest groups using this information should consult with neighboring jurisdictions to coordinate efforts that conserve natural resources and create open space linkages while allowing for economically viable development.

2) Local municipalities should identify opportunities to link other possible natural resource sites not mapped during this survey. This would include small patches of land, tree and fence row plantings, agriculture land and open fields (greenways).

3) Field inventories should be conducted on identified potential conservation areas. This fieldwork would provide much needed additional site-specific data that should be considered when developing in and around such areas.

4) All identified sites, regardless of their priority, have significance to their local setting. This is especially true in areas that have experienced a high degree of development and landscape fragmentation.

5) A direct relationship exists between natural area protection and long-term water quality. With Lake St. Clair as the focal area of this project and the potential impact on the economy associated with degradation of this resource, natural area protection should be integrated into local water quality management plans.

6) Municipalities should adopt a comprehensive conservation/greenway plan. The conservation of potential conservation areas is most effective and successful, in the context of an overall conservation/greenway plan.

7) Funding should be secured to update the mapping and assessment of this project's potential conservation areas.

8) Efforts to conserve potential conservation areas should include on-going site assessment and stewardship.

9) Local units of government in Ontario, Michigan and Walpole First Nation should undertake widespread distribution of this information in order to build awareness and encourage long-term resource planning and stewardship. Knowledge of potential conservation areas is meaningless unless action is taken to ensure that they will remain part of this area's natural heritage.

10) When establishing sites for possible field inventory, each community, group or individual should consider all available criteria in conjunction with their unique local conditions. Site selection may well be influenced by local growth pressure and ownership of the land.

Section VII Endnotes

Dale, V. H., S. Brown, R. A. Haeuber, N. T. Hobbs, N. Huntly, R. J. Naiman, W. E. Riebsame, M. G. Turner and T. J. Valone. 2000. Ecological Society of American Report: Ecological Principles and Guidelines for Managing the Use of Land. Ecological Applications. 10(3):639-670.

Dramstad, Wenche E., J. D. Olson and R. T. T. Forman. 1996. Landscape Ecology Principles in Landscape Architecture and Land-Use Planning. Island Press, Washington, D.C.

Forman, Richard T. T. and Michel Gordon. 1986. Landscape Ecology. Wiley, New York.

Leach, M. K. and T .J. Givnish. 1996. Ecological Determinants of Species Loss in Remnant Prairies. Science. Vol. 273:1555-1558.

Peck, Sheila. 1998. Planning for Biodiversity: Issues and Examples. Island Press, Washington, D.C.

Rosenberg, K. V., R. W. Rohrbaugh, Jr., S. E. Barker, J. D. Lowe, R. S. Hames and A. A. Dhondt. 1999. A land managers guide to improving habitat for scarlet tanagers and other forest–interior birds. The Cornell Lab of Ornithology.

---

i. Herman, K. D., L. A. Masters, M. R. Penskar, A. A. Reznicek, G. S. Wilhelm, and W. W. Brodowicz. 1997. Floristic quality assessment: Development and application in the state of Michigan (USA). Natural Areas Journal 7:265-279. Accessed 28 January 2005: www.michigandnr.com/publications/pdfs/HuntingWildlifeHabitat/FQA.pdf

ii. Southerland, M.T. and J.B. Stribling. 1995. Status of biological criteria development and implementation. In Davis, W. and T. Simon (eds.) Biological Assessment and Criteria: Tools for Water Resources Planning and Decision Making. Lewis Publishers, Inc, Chelsea, MI. pp. 79-94.

Section VIII. Protection and Restoration Recommendations and Guidelines

Introduction

Setting protection and restoration goals can be a difficult task, especially for an area that incorporates a 430 square mile (1,114 square kilometer) lake and 1,176 square miles (3,046 square kilometers) of land. Not only is it a large geographic area, but it spans two countries, one sovereign First Nation, incorporates hundreds of political jurisdictions and numerous conservation organizations and agencies. Obviously, it would be impossible to develop an individual plan for each organization and jurisdiction within the purview of this project. As an alternative, this section presents a set of conservation and restoration guidelines and recommendations from the perspective of the entire project area that can be used by local municipalities, land trusts and other agencies and organizations to engage in more integrated conservation and restoration planning, in which individual projects are seen as part of a system-wide network of conservation and restoration areas. Using this integrated and holistic approach, individual projects can be undertaken to meet local needs and priorities in the context of maximizing benefits to the larger ecosystem.

HIGHLIGHT

Within the Lake St. Clair coastal zone, there are very few natural communities or ecological systems that that are considered self-sustaining.

There are clear benefits from having a significant proportion of a region's lands in natural cover (see sidebar), but only a small percentage of the lands surrounding Lake St. Clair remain in such a state. Integrated conservation and restoration planning for the region necessitates a three-pronged approach: protection of existing high quality natural areas; enhancement of degraded natural lands; and restoration of sufficient additional lands to create a matrix of interconnected self-sustaining natural communities with intact ecological functioning. Within the Lake St. Clair coastal zone, there are very few natural communities or ecological systems that that are considered self-sustaining, with a full complement of associated plants and animals. Providing protection to those sites or portions of those sites should be of the highest priority. But what should be done with the remaining small, scattered fragments of natural vegetation? How do we improve the current condition of those sites that still have some ecological integrity and provide habitat for rare plants and animals? Finally, how do we strategically target additional land for restoration? How much land? Where? Which natural communities?

Today only 0.5 percent of the land in the Michigan portion of the project area could be considered high quality natural area in fair condition. Although specific values for the Ontario portion are unavailable they are probably similar. As noted in Tables VIII B - 1 and VIII B - 2 later in this section, the natural communities that have experienced the greatest losses in area are

CASE STUDY

The Value of Nature

Why should we be so concerned about the loss of natural lands? Natural lands provide ecosystem goods and services that are essential to humans. Ecosystem services include things like air and water purification, reduction of toxic substances, detoxification of various substances, i.e., via bacteria, etc., nutrient storage and cycling, climate regulation, soil development, flood control, pest outbreak control and pollination[1,2]. Ecosystem goods include things like timber, gravel, food, oil, gum, fiber, dye and other products we use to nourish, clean, clothe, shelter and refresh ourselves. Plants are also important providers of genetic resources for pharmaceuticals and agricultural products. Because someone did not establish a company or hire people to produce these goods and services, they are often undervalued or unvalued. Unlike goods and services produced by people, we do not have well established mechanisms to quantify the value of goods and services produced by nature. Four major industries in Michigan - natural resource-based tourism, forestry, mining and agriculture - are dependent on the land. Together, they account for approximately $63.2 billion or 29 percent of Michigan's economic[3] output, but this figure only reflects the cost of converting an existing resource – crystalline lakes, immense forests, minerals, ore and fertile soils – to marketable commodities, rather than the value of the resource itself. (cont.)

(cont.) How many acres/hectares of natural lands do we need to conserve to ensure that the ecosystem continues to produce the goods and services that matter? The answer depends on what goods and services are needed and in what quantities. Like any other good or service, we must make sure that the "balance" in our natural resources "account" is sufficient to sustain the ecosystem goods and services we need and enjoy. This, in turn, requires that we quantify the value of these goods and services. It is difficult, but attempts are now being made to quantify the value of nature's services. In *Making Smart Growth Work*, Porter suggests that open space can be valued by its market value, contingent value (willingness to pay), production value, enhancement value (value added to adjacent properties), fiscal benefits (cost/benefit analysis), natural system value and intangible value[4]. Other ecosystem service valuation methodologies have been explored and are discussed in a series of articles published in the May 2001 issue of the Stanford Environmental Law Journal.[5]

lakeplain prairie (98.2 percent loss) and lakeplain oak openings (92.7 percent loss). There has also been a large decrease in all forest types including mesic southern forest, dry-mesic southern forest, southern floodplain forest and southern swamp. Although there was only a 30 percent loss of Great Lakes marsh overall, most of the marsh has been diked or hydrologically disconnected from Lake St. Clair. A total of 102 rare species occur in the Michigan portion of the project area and 68 with the Ontario portion. The vast majority of these species are associated with lakeplain prairie, lakeplain oak opening, Great Lakes marsh and open water. The average size of natural patches - areas on the landscape differing in appearance from their surroundings - was 2.42 acres in 2002 (nearly 1 hectare), which represents a very high degree of fragmentation; much of what remains has been degraded by overexploitation, invasive species and the disruption of natural processes such as fluctuating water levels and fire. These stressors are discussed in detail in Section V of this document.

VIII. A. Guidelines for Conservation and Restoration

Setting Goals and Objectives

An integrated planning approach requires that individual projects be planned and undertaken in the larger context of the Lake, its coastal area and ultimately the watershed. Management of Lake St. Clair and its watershed has been addressed, partially or wholly, by several plans, each with goals and objectives for the project area or large portions of it. They include:

- Lake Erie Lake Area Management Plan (LaMP) (2004) - *www.epa.gov/glnpo/lakeerie/2004update*
- St. Clair River Habitat Management Plan - *www.friendsofstclair.ca/pdf/hab_mgmt_plan.pdf*
- A Natural Heritage System for the St. Clair River Watershed - *www.friendsofstclair.ca/pdf/nhs.pdf*
- Lake St. Clair Management Plan (U.S. Army Corps, in progress) - *www.glc.org/stclair/manageplan*
- St. Clair River Area of Concern (1998)
  U. S. EPA - *www.epa.gov/glnpo/aoc/st-clair.html#pubs*
  Environment Canada - *www.on.ec.gc.ca/water/raps/stclair/intro_e.html*
- Clinton River Area of Concern - *www.epa.gov/glnpo/aoc/clintriv.html*
- Detroit River Area of Concern
  Environment Canada - *www.on.ec.gc.ca/water/raps/detroit/intro_e.html*
  U. S. EPA - *www.epa.gov/glnpo/aoc/detroit.html*

HIGHLIGHT

The existing plans that address Lake St. Clair natural resource management provide very little guidance in the way of specific goals or objectives to help communities make difficult land use decisions.

In addition, the recently-published *Explore Our Natural World: A Biodiversity Atlas of the Lake Huron to Lake Erie Corridor*[6] (*www.epa.gov/ecopage/stclairbiodiv*) provides complementary background on the natural communities in the region and a variety of related issues.

These resources should be considered in the development of general goals and objectives for Lake St. Clair coastal habitat. However, despite the tremendous

amount of information contained in these and other plans, they provide very little guidance in terms of specific objectives to help communities and organizations make difficult land use decisions. For example, typical goals for loss of fish and wildlife habitat are, "no further loss of productive fish and wildlife habitat, net gain of restored and protected habitat in accordance with fish and wildlife management plans and local measures in place to protect conserved and restored sites in perpetuity." A goal from the St. Clair River Area of Concern's (AOC) Remedial Action Plan to address no further loss of productive fish and wildlife habitat is to "ensure that sufficient enforceable mechanisms are in place to protect existing aquatic and wetland habitat from cultural destruction and degradation." Other AOC's have developed goals that incorporate 1) self sustaining communities, 2) acceptable normal levels of deformities and reproductive problems, 3) diverse macroinvertebrate communities and 4) diverse animal and fish communities.

Although still broad and non-specific, the Lake Erie LaMP provides useful guidance in its vision and habitat goals. Key provisions of the Lake Erie LaMP Vision include:

- Natural resources are protected from known, preventable threats
- Native biodiversity and the health and function of natural communities are protected and restored to the greatest extent feasible
- Natural resources are managed to ensure that the integrity of existing communities is maintained or improved
- Land and water are managed such that water flow regimes and the associated amount of materials transported mimic natural cycles

Similarly, the Lake Erie LaMP Habitat Goals include:

- Protect and maintain high quality habitats and ecosystem processes that sustain them.
- Restore, rehabilitate, enhance and reclaim degraded habitats and impaired hydrological function.

These statements set a general direction, but do little for determining what to protect and restore, how much to protect and restore and where these activities should take place on the landscape. A conceptual framework for conservation and restoration planning is needed to apply these broad goals in developing a series of specific recommendations. Both are presented below.

HIGHLIGHT

Biodiversity is the variety of living organisms, the genetic differences among them, the communities and ecosystems in which they occur and the ecological and evolutionary processes that keep them functioning.

What exactly are we trying to conserve? Most conservation references today focus on the conservation of an area's biological diversity or biodiversity. Biodiversity is most simply defined as the variety of life on earth and its processes. More specifically, it is the variety of living organisms, the genetic differences among them, the communities and ecosystems in which they occur and the ecological and evolutionary processes that keep them functioning, yet ever changing and adapting[7]. While organisms and communities are disappearing too rapidly to adapt, the first impulse is often simply to preserve them. At the same time, it is critical to remember that isolated organisms or remnants of natural communities are not necessarily viable in the long run; they may lack genetic variability to respond to natural environmental changes, specific co-adapted organisms such as pollinators or critical natural processes – multiple factors that contribute to biodiversity.

FACT

Biodiversity is typically measured at several levels of organization: genes, species, communities, ecosystems and landscapes.

Biodiversity is typically measured at several levels of organization: genes, species, communities, ecosystems and landscapes. The principles of biological protection and restoration are based on several assumptions: 1) biodiversity depends on functioning ecosystems, 2)

biodiversity, at all levels, is integral to ecosystem function, 3) priority should be given to keystone species and 4) ecological redundancy is important to the long-term persistence of ecosystems. In addition, it is important to realize that native ecosystems are complex systems that we still do not fully understand and 5) certain natural processes and disturbances are critical to the health and evolutionary pathways of native ecosystems and their associated biota[8].

HIGHLIGHT

The Nature Conservancy defines ecological integrity as the ability of an ecological system to support and maintain a community of organisms that has species composition, diversity and functional organization comparable to those of natural habitats within a region.

According to Daily[9], protected and restored ecosystems should be self-sustaining and biodiversity should be restored and maintained at as high a level as possible. In addition, Daily recommends that the community types that should most frequently be targeted for restoration are those that are comprised of area limited species and critical habitat that is poorly represented in the surrounding natural landscape.

The Nature Conservancy (TNC) recommends that conservation efforts focus on species, ecological communities and ecological systems, with a special emphasis on ecosystem integrity and species viability. TNC defines ecological integrity as the ability of an ecological system to support and maintain a community of organisms that has species composition, diversity and functional organization comparable to those of natural habitats within a region (reference sites). An ecological system or species has integrity or is viable when its dominant ecological characteristics - composition, structure, function and processes - occur within their natural ranges of variation and can withstand and recover from most disturbances[10]. In other words, ecosystems and populations of plants and animals should be self-sustaining.

To truly conserve biodiversity, TNC recommends that there be a sufficient number, distribution and quality of each native species and ecosystem to ensure their long term persistence within an ecoregion[11]. Capturing multiple examples is necessary to capture variability and to ensure persistence in the face of natural and human disturbances. However, it is an impossible task to track all native species of biota. The native biota of an area includes innumerable species unknown or at best poorly known to science embedded in numerous ecological systems whose webs of biotic and abiotic interactions are only poorly understood[12].

VIII. B. Setting Conservation and Restoration Targets: The Coarse Filter - Fine Filter Approach

One solution to this problem is to identify conservation targets. TNC defines conservation targets as a limited number of species, natural communities, or ecological systems chosen to represent the biodiversity of a given area. Due to the limitations of using individual species as filters for other species, it is recommended to initially select ecological communities or systems as coarse filter targets[13, 14]. If ecological communities are to work as coarse filters for all associated plants and animals they must:

1) be conserved as often as possible at a size and scale at which they naturally occurred prior to major human impacts
2) be conserved as part of dynamic, intact, landscape mosaics
3) maintain some level of connectivity between communities and
4) contain a full complement of their associated flora and fauna in so far as it is known[15].

HIGHLIGHT

Conservation targets are useful when a definitive knowledge of the number, distribution and quality of each native species and ecosystem is not available, which is usually the case.

In addition, TNC also recommends that smaller and rarer natural community types (lakeplain prairie, prairie fen, coastal plain marsh and bog) should be represented at a higher number in the landscape than larger and more common community types such as mesic southern forest.

This coarse filter approach should then be followed by the selection of species with unique ecological requirements that cannot be met through the conservation of natural communities or ecological systems. Wide ranging, rare, extremely localized or keystone species are all likely to need such fine filter strategies. One approach is to identify a set of species typical of or restricted to a particular community in the ecoregion and then use available information on their space, resource and breeding habitat needs to determine minimum area requirements for the community type[16]. Building on this concept, Lambeck recommends the use of a suite of focal species to define different spatial and compositional attributes that must be present in a landscape and their appropriate management regimes. All species considered at risk are grouped according to the processes that threaten their persistence. Within each group, the species most sensitive to the threat is used to define the minimum acceptable level at which that threat can occur. Species are categorized as either area-limited, resource-limited, dispersal-limited and/or process-limited[17]. Combined, this has commonly been referred to as the coarse filter-fine filter approach to biological conservation.

CASE STUDY

What exactly do we mean by restoration?

Restoration can refer to many different things. According to the Webster Dictionary, restoration is defined as "bringing something back to a former position or condition." In regards to Areas of Concern (AOCs) or Remedial Action Plans (RAPs), restoration typically refers to the improvement of beneficial use impairments. Common examples of beneficial use impairments are 1) restrictions on fish and wildlife consumption, 2) degradation of fish and wildlife populations, 3) bird or animal deformities or reproductive problems, 4) beach closings, 5) degradation of aesthetics, or 6) restrictions on drinking water consumption. Although restoration (when used in the context of a geographical area such as Lake St. Clair) typically refers to the movement of a degraded native ecosystem or community towards a higher state of ecological health or integrity, it is important to realize that restoration is really defined by the goals of the project. Different types of goals can be divided into several themes – active recreation, wildlife related recreation, biological diversity, ecosystem health and human health.

According to the Society for Ecological Restoration (SER), ecological restoration is an intentional activity that initiates or accelerates the recovery of an ecosystem with respect to its health, integrity and sustainability. Frequently, the ecosystem that requires restoration has been degraded, damaged, transformed, or entirely destroyed as the direct or indirect result of human activities[18]. Restoration attempts to return an ecosystem to its historic "developmental trajectory". This implies that there is not some sort of climatic state in which an ecosystem remains in a static equilibrium. Rather, ecosystems are dynamic assemblages of plants and animals that are in a constant state of flux as a result of environmental change (i.e., climatic), competition, stress, natural selection and natural disturbances.

Restoration methods can vary widely among projects depending on the extent and duration of past disturbances, cultural conditions that have shaped the landscape and contemporary constraints and opportunities[19]. Restoration may involve removing a dam or dike, filling in a ditch, breaking drain tile, reintroducing native species, removing invasive species, setting back succession and/or reintroducing natural processes like fire and flooding. (cont.)

How Much Habitat is Enough?

In a highly altered, fragmented, human dominated landscape such as the Lake St. Clair coastal zone, simply protecting the best remaining examples of natural communities and populations of plants and animals will not ensure their long-term persistence. Over the years, scientists have realized that H ecosystems and populations of plants and animals cannot persist in small isolated patches surrounded by incompatible land uses. If the goal is a healthy, functional Lake St. Clair and coastal zone, conservation strategies will have to go beyond protecting the best remaining occurrences. Large scale restoration is critical in protecting the long-term viability of the remaining high quality sites and populations of rare species, as well as enhancing water quality, but careful planning is required to determine which natural communities should be restored, in what quantities and where these lands should be located.

(cont.) How do we know we have successfully restored an ecosystem? NOAA states that the goal for the restoration of any natural ecosystem is to recover autogenic (self-renewing) processes to the point where assistance from restoration practitioners is no longer needed[20]. SER International asserts that the goal of every ecological restoration project is to reestablish a functional ecosystem of a designated type that contains sufficient biodiversity to continue its maturation by natural processes and to evolve over longer time spans in response to changing environmental conditions[21].

Below are attributes of what the Society for Ecological Restoration considers a restored ecosystem[22]:

1. It contains a characteristic assemblage of the species that occur in the reference ecosystem and that provide appropriate community structure.
2. It consists of indigenous species to the greatest practicable extent.
3. All functional groups necessary for the continued development and/or stability of the restored ecosystem are represented.
4. Its physical environment is capable of sustaining reproducing populations of the species necessary for its continued stability or development along the desired trajectory.
5. It functions normally for its ecological stage of development and signs of dysfunction are absent.
6. It is suitably integrated into a larger ecological matrix or landscape, with which it interacts through abiotic and biotic flows and exchanges.
7. Potential threats to its health and integrity from the surrounding landscape have been eliminated or reduced as much as possible.
8. It is sufficiently resilient to endure the normal periodic stress events in the local environment that serve to maintain the integrity of the ecosystem.
9. It is self-sustaining to the same degree as its reference ecosystem and has the potential to persist indefinitely under existing environmental conditions.

Two recent publications have attempted to consolidate scientific information from an array of sources into a set of generic conservation guidelines. *Conservation Thresholds for Planners* (*www.elistore.org/reports_detail.asp?ID=10839*), developed by the Environmental Law Institute (ELI) and published in 2003, focuses on providing recommendations to land use planners on patch size, edge effects, riparian buffers and connectivity. *How Much Habitat is Enough? A framework for guiding habitat rehabilitation in Great Lakes Areas of Concern* (*www.on.ec.gc.ca/wildlife/docs/habitatframework-e.html*), produced by Environment Canada (EC) and published in 2004, was developed for Remedial Action Plan teams and Public Advisory Committees who are working to rehabilitate ecosystems in 17 Canadian Areas of Concern across the Great Lakes basin. The purpose of this latter publication is to 1) assist in the selection of fish and wildlife habitat targets as part of delisting criteria and 2) prioritize sites for rehabilitation projects. The guidelines provided are not landscape or watershed specific and they are categorized into guidelines for wetland, riparian and forest habitats. As such they have important potential application to the Lake St. Clair project area. The following are examples of specific targets for habitat conservation and restoration offered by these existing publications.

- 20-60% of natural land coverage within a watershed – maintain biodiversity (ELI)
- Maximum of 10% imperviousness in a watershed – maintain water quality (EC)
- 75% of stream length should be naturally vegetated with a minimum 30 m buffer along both sides of stream – maintain and enhance water quality (EC)
- Establish 100 m wide riparian buffers – maintain and enhance both water quality and wildlife habitat (ELI)
- Minimum size block of habitat patch = 137.5 acres (55.65 hectares)– habitat for edge sensitive species (ELI)
- Greater than 10% of each watershed should be in wetland habitat – enhance water quality and flow regime (EC)
- Greater than 30% of watershed should be in forest cover – provide wildlife habitat and decrease water runoff (EC)
- Corridors should be a minimum of 50m to 100m in width - designed for species movement (EC)
- Establish buffers up to 230 to 300 m around edges of habitat – minimize edge influences such as predation, invasion of exotic species and nest parasitism (ELI)

Considerations for Setting Project Specific Targets

Using the preceding approach and general guidelines as a conceptual framework, the next step is to set project-specific goals and targets. Below are some key questions that should be asked in the context of the integrated approach offered above:

- What are you trying to conserve/restore?
  - Aquatic species habitat
  - Species diversity
  - Focal species
  - Rare species
  - Natural communities
  - Functional landscapes
  - Water Quality
- Why do you want to conserve/restore it?
  - Uniqueness/rarity
  - Important functions/services
  - Economic importance
  - Vulnerability
- How much do you need to conserve/restore?
  - Historic patch size and total acreage/hectares
  - Key ecological processes
  - Long term population viability of key species
- Where are you going to conserve/restore it?
  - Where there is an obvious or unique opportunity (e.g., existing open parcel)
  - Threats—parcel(s) threatened by development or other stressors
  - Large blocks
  - Connecting patches—again, examine what is being done elsewhere or nearby to maximize value added of multiple projects
  - Historic locations

HIGHLIGHT

It is important to realize that restoration is really defined by the goals of the project and the restoration site.

Although restoration typically refers to the movement of a degraded native ecosystem or community towards a higher state of ecological health or integrity, it is important to realize that restoration is really defined by the goals of the project and the restoration site. Restoration methods can vary widely among projects depending on the extent and duration of past disturbances, cultural conditions that have shaped the landscape and contemporary constraints and opportunities.

Related Questions by Category

Answering the general project questions above may require obtaining detailed scientific and other information about the area under consideration. The following questions should be considered in getting this more detailed information.

Biodiversity

- What was the historical distribution and quantity of each community type?
- What is the present distribution and quantity of each community type?
- How unique is the specified community type?
- What rare species does the community type support?
- What functions have been lost?
- What aspects should be restored?
- Does the community exist in relatively natural patterns, sizes and shapes?

- Does the community contain a complete set of native species typically associated with a healthy example of that type of community?
- Are there species that play a critical role in the long term viability of the natural community?
- Are there opportunities for restoring the specific community type? If so, where?
- Are there native species whose future viability will not necessarily be met through the conservation of natural communities?

Landscape Integrity

- What degree of fragmentation is present on the landscape?
- How much of the project area is covered by natural vegetation?
- What is the average size of natural vegetation patches?
- What is the level of connectivity between patches?

Aquatic Integrity

- How important is water quality and quantity to the function and health of natural communities and aquatic organisms in the watershed?
- What is the level of water quality in the watershed?
- How much of the riparian zone is vegetated?
- How much of the study area is urbanized and how is it distributed?

Stressors

- What are the stressors to each of the conservation targets?
- What are the biggest stressors to the conservation targets?
- Are there significant stressors that are more imminent than others?
- Are there ways to minimize the impacts of these stressors?

HIGHLIGHT

This Habitat Assessment, the Integrated Coastal Management Tool and the supporting natural community and species abstracts can provide answers to many of the questions for determining conservation and restoration targets for specific areas within the overall project area.

For the Lake St. Clair coastal area, this Habitat Assessment, the Integrated Coastal Management Tool described in Section VII and the supporting natural community and species abstracts (*www.glc.org/habitat/abstracts.html*) can provide answers to many of the questions for determining conservation and restoration targets for specific areas within the overall project area. The following tables provide an overview of presettlement distributions and quantities of the natural communities within the project area. This historic information can help in establishing restoration targets. In Michigan, for example, only 1.8 percent of the presettlement extent of lakeplain prairie, a globally rare natural community, remains. This table would be helpful, for example, in setting targets under Recommendation 2, Goal 3 in this section, which calls for "increasing the acreage of globally rare natural communities to at least 20 % of original (i.e., historic) coverage (or equivalent hectares)."

Summary of Lake St. Clair Coastal Project Area Natural Community Change

Table VIII B - 1 MI. Circa 1800 vs 2000 vegetation cover

Communities	Acreage circa 1800	% coverage	Acreage in 2000	% coverage	Loss in acres	% remaining	%change
Deciduous forest	199,537	62.9	40,304	12.7	159,233	20.2	-79.8
Hardwood swamp	68,693	21.7	13,302	4.2	55,391	19.4	-80.6
Lakeplain oak openings	5,196	1.6	327	0.1	4,869	6.3	-93.7
Lakeplain prairie	22,686	7.2	419	0.1	22,267	1.8	-98.2
Emergent wetland/aquatic bed/shrub swamp	19,450	6.1	13,601	4.3	5,849	69.9	-30.1
Other	1,539	0.5			1,539	0.0	-100.0
Total	317,101	100.0	67,953	21.4	49,148	21.4	-78.6

Table VIII B - 2 Ontario. Circa 1800 vs 2000 vegetation cover in acres

Communities	Acreage circa 1800	% coverage	Acreage in 2000	% coverage	Loss in acres	% remaining	% change
Deciduous forest	266,626	61.8	15,925	4	(250,701)	6.0	-94.0
Hardwood swamp	90,601	21	3,408	1	(87,193)	3.8	-96.2
Lakeplain oak openings	6,903	1.6	889*	.2	(6,903)	12.8	-87.2
Lakeplain prairie	31,063	7.2	1,160*	.3	(29,903)	3.7	-96.3
Emergent wetland/aquatic bed/shrub swamp	34,234	7.9	24,109	6	(10,125)	70.4	-29.6
Other	2,157	0.5	365	0	(1,792)	16.9	-83.1
Total	431,433	100	43,807	10	(387,777)	10.2	-89.8

*Data from Walpole Island only.

Preamble to Recommendations

Biodiversity is a critical component of ecological health and integrity. Although difficult to explain in concrete terms, it can best be conserved through adequate representation and landscape integrity. Representation can best be addressed through the coarse filter fine filter approach described in the guidelines discussed earlier in this section and aims to achieve species or community viability. Landscape integrity is critical to maintaining the long-term viability of species and natural communities. Landscape integrity addresses the health of the larger ecosystem, as well as large scale stresses impacting individual components across the landscape. Without landscape integrity, maintaining fragmented patches of habitat and isolated populations of flora and fauna becomes akin to keeping a patient alive on a respirator in the hopes that we can figure out a cure in the future. Both representation (to ensure viability) and landscape integrity are needed to maintain long term biodiversity within a region. The following recommendations are aimed at conserving and restoring representation and landscape integrity.

HIGHLIGHT

Both representation and landscape integrity are needed to maintain long term biodiversity within a region.

Restoration goals should be based on the portion of the overall goals of the project that can not be met through the conservation of existing lands. First priority should be placed on underrepresented communities, particularly G1 and G2 natural community types (see top box on pg. 214). Special emphasis should be placed on restoring connectivity

Species and Community Risk Rankings

The Natural Heritage Network, of which Michigan Natural Features Inventory and the Ontario Natural Heritage Information Centre are both members, uses a standardized ranking system to classify and target the species and ecosystems that are most at risk for inventory, protection, research and management. The basic classification scheme consists of a letter, denoting at what scale they are considered and a number indicating their status or degree of imperilment.

Scale:
G – globally
N – nationally
S – sub-nationally (state or province)

Status
1 – Critically Imperiled
2 – Imperiled
3 – Vulnerable to Extirpation
4 –Apparently Secure
5 –Demonstrably Widespread, Abundant and Secure

Accordingly, a natural community such as lakeplain oak opening, which is ranked G1/S1, is considered imperiled globally as well as at the state and province scale.

Michigan Natural Features Inventory Element Occurrence Rankings

While any element occurrence – a population of a rare species or remnant natural area - is an asset, not all are of equal ecological value. For an individual species, an element occurrence consists of not just a single plant but rather the fully occupied habitat that contributes to the long term persistence of the species at a particular location. A population that spreads across a large area of high quality habitat, with many individual plants, has a much better chance of long term viability than isolated plants which may persist in the midst of rapidly changing landscapes. For community types, an occurrence represents a defined area that contains a characteristic species composition and structure.

Occurrences are ranked according to their estimated long-term viability:
A – Excellent
B – Good estimated viability
C – Fair estimated viability
D - Poor estimated viability
E – Verified extant (viability not assessed)
H – Historical
F – Failed to find
X – Extirpated

In some cases, letters "A", "B", "C" and "D" may be combined to express a range of estimated viabilities, i.e., AC – excellent to fair. In addition, the "?" qualifier may be used with these four letters to indicate uncertainty[23].

between the different communities of the Great Lakes marsh system (Great Lakes marsh, lakeplain prairie, lakeplain oak openings). Acreage/hectare goals should be based on historical extent and patch size should be determined by the range and mean of historical patch size and/or the minimal dynamic area. Second priority should be given to the remaining natural communities historically found in the study area. Third priority should be placed on improving the integrity of existing natural communities that are in fair to poor condition and maintaining the condition of high quality remnants. This is particularly important for lakeplain prairie, lakeplain oak openings and Great Lakes marsh. Fourth priority should be given to the overall integrity of the landscape. This is probably best addressed by improving the scores of existing potential conservation areas by addressing size, shape and connectivity. Lastly, it is important to address widespread threats. No restoration plan can be truly successful if it doesn't address threats such as water and air pollution, urban expansion, fragmentation and intensive recreational pressure.

There may be circumstances where several of these priorities can be met on the same parcel of land. A matrix could be developed to help determine where these might occur on the landscape and priorities could be based on the cumulative contributions to ecosystem health rather than assessing each site on an individual criterion. Below is a list of criteria to analyze when determining restoration targets:

- Number of existing A-B ranked (viable) occurrences for each natural community type (see left text box for discussion of ranking).
- Size of each natural community occurrence compared to recommended minimum viable sizes
- Percent remaining of original acreage/hectares for each community type
- Percent natural vegetation cover remaining in each subwatershed
- Number of intact Great Lakes marsh complexes (determined by GIS)
- Percentage of Potential Conservation Area acres/hectares with a high quality score
- Percent of riparian zone (Lake St. Clair and all rivers/stream segments within study area) with 100 m buffer of natural vegetation.

As with the target-setting questions listed earlier in this section, many of the answers to these questions can be found throughout this document, particularly with the online abstracts (www.glc.org/habitat/abstracts.html), the Potential Conservation Area Analysis and/or the Integrated Coastal Management tool described in Section VII.

VIII. C. Recomendations

1) Maintain and Restore Adequate Representation of Native Biodiversity

1-a. Protect an adequate number of viable natural community occurrences

i) Protect at least 2 viable examples of each community type.

ii) Protect at least 4 viable examples G1 or G2 ranked communities such as Great Lakes marsh, lakeplain wet-mesic prairie and lakeplain wet-mesic prairie

Tools:

- High Quality Natural Communities (determined by Heritage Programs)
- Unchanged vegetation within high priority Potential Conservation Areas
- Unchanged vegetation within lower priority Potential Conservation Areas
- Minimum viable sizes for community types:
  Great Lakes marsh > 2,500 (1,012 hectare) patch (Environment Canada, 2004)
  Forest types > 500 acre (202 hectare) patch (Environment Canada, 2004)
  Grassland/savannah types > 250 acre (102 hectare) patch (Henslow sparrow reference)
  Other wetland types = no minimum size for viability

1-b. Improve ecological conditions of degraded natural communities

i) Identify unchanged vegetation

ii) Conduct surveys to assess condition of existing remnants

iii) Identify key threats/stresses

iv) Determine desired level of health

v) Develop a management plan

Although patches of various natural community types exist throughout the area, many of these patches are experiencing declining health due to past and present land uses, resource exploitation, pollution, habitat destruction, fragmentation, invasive species, altered hydrology and fire suppression. As a result, many of these natural communities may not be functioning in a state that is capable of self repair and are self sustaining. While spatial (GIS) data can provide a general sense about current land use, land cover and habitat extent and conditions, including identifying potential unchanged land cover and potential conservation areas as was done for this project. However, GIS does not replace on-the-ground surveys and analyses. GIS data and tools should be used in concert with field surveys to assess the actual quality and restoration potential of natural areas. The recommended course of

HIGHLIGHT

The most effective way to assess quality is to conduct on the ground biological surveys.

action is to identify the highest quality patches and maintain those patches through management activities and restoring adjacent lands.

Site selection involves examination of historical or pre-disturbance conditions, degree of alteration, present ecological conditions and other factors[24]. Factors to consider include: soils, water table fluctuations, hydrologic alterations, species assemblages, species richness, exotic plants and animals, roads, seedbank and seed sources.

Tools:

- Unchanged vegetation layer (project data available for Michigan only; no data for Ontario)
- Priority Conservation Area Analysis (see Section VII of this document)
- Surveys by ecological experts
- Floristic quality index
- Index of Biological Integrity
- Marsh Monitoring Program

1-c. Increase acreage/hectares of underrepresented natural communities

i) Increase acreage/hectares of globally rare natural communities (lakeplain prairie, lakeplain oak openings, Great Lakes marsh) to at least 20% of original acreage (or equivalent hectares). Ensure there are at least 4 viable occurrences for each type.

ii) Increase acreage of common natural communities that are currently uncommon in the study area (<20% of historic coverage) to at least 20% of original acreage or equivalent hectares. Ensure there are at least 2 viable occurrences for each type.

Based on the landscape analysis of natural communities in the area, almost all natural communities could be considered rare due to the high degree of modification to the landscape. Lakeplain prairie currently occupies less than 1 percent of its historical extent in Michigan. In the project area, there are only a few small remnants remaining in Michigan, while Walpole Island First Nation still contains several large patches. Lakeplain oak openings, closely related to lakeplain prairies, currently occupy only a few sites in Michigan and Ontario. Moving closer towards the open water, Great Lakes marsh has diminished by 20,000 acres (about 8,094 hectares) in Lake St. Clair since 1878 and the majority of remaining marsh is controlled by dikes and water control structures.

HIGHLIGHT

Any restoration activities in this area should strongly consider all three of these very rare, fragile, nearshore natural communities:

- lakeplain prairie;
- lakeplain oak opening; and
- Great Lakes marsh

Lakeplain prairie, lakeplain oak openings and Great Lakes march are all natural communities considered globally imperiled by The Nature Conservancy. In addition, all three support the vast majority of rare plants and animals found within the Lake St. Clair buffer zone. Any restoration activities in this area should strongly consider all three of these very rare, fragile, nearshore natural communities.

Tools:

- Identify circa 1800 vegetation lost to agriculture and old fields
- Prioritize by proximity to Potential Conservation Areas
- Prioritize by proximity to same unchanged vegetation type – outside of Potential Conservation Areas

1-d. Protect adequate number of viable occurrences for species in greatest need

i) Protect all remaining G1 – G3 (globally rare ranked 1-3) plant and animal occurrences (known as "element occurrences) last observed since 1980. The 91 occurrences of 14 different elements are listed in Table VIIIC – 1 below.

Type	Scientific Name	Common Name	COSEWIC	US	MI	ONT	Global Rank	ONT S Rank	MI S Rank
Plant	Agalinis skinneriana	Skinner's Agalinis	Endangered		E		G3	S1	S1
Plant	Lycopodiella subappressa	Northern Appressed Clubmoss			SC		G2		S2
Plant	Platanthera leucophaea	Prairie Fringed Orchid	Endangered	LT	E		G2	S2	S1
fish	Acipenser fulvescens	Lake Sturgeon	Not at Risk		T	NIAC	G3G4	S3	S2
fish	Ammocrypta pellucida	Eastern Sand Darter	Threatened		T		G3	S2	S1S2
fish	Notropis anogenus	Pugnose Shiner	Endangered		SC	THR	G3	S2	S3
fish	Noturus stigmosus	Northern Madtom	Endangered		E	THR	G3	S1S2	S1
insect	Euphyes dukesi	Duke's Skipper	(null)				G3	S2	
insect	Papaipema beeriana	Blazing Star Borer			SC		G3		S1S2
insect	Papaipema sciata	Culvers Root Borer			SC		G3G4		S2S3
mussel	Epioblasma torulosa rangiana	Northern Riffleshell		LE	E		G2T2		S1
mussel	Epioblasma triquetra	Snuffbox	Endangered		E		G3	S1	S1
mussel	Simpsonaias ambigua	Salamander Mussel			E		G3		S1
mussel	Villosa fabalis	Rayed Bean			E		G1G2		S1

All G1-G3 insects and plants in the Lake St. Clair coastal area are associated with lakeplain prairie. In general, mussel and fish species are both very difficult to protect from a spatial standpoint. A best bet approach is maintaining and establishing buffers along riparian zones, particularly upstream of known populations.

Tools:

Due to the high degree of fragmentation and relatively strict requirements of G1-G3 species found here, all G1-G3 plant and animal occurrences in the study area should be captured using a combination of the coarse filter and landscape integrity approach described throughout this section.

2) Maintain and Restore Landscape Integrity (Supporting Landscape)

2-a. Improve overall ecological integrity of the study area by increasing the size and improving the shape of Potential Conservation Area's.

i) Strive towards 20-60% natural vegetation coverage in each subwatershed (Environmental Law Institute, 2003).

ii) Increase the score of 50% of total Potential Conservation Area acreage or equivalent hectares (not 50% of Potential Conservation Areas) to 15 or higher in Ontario and 19 or higher in Michigan (these represent roughly half of the total possible points respectively. (These numbers differ due to data limitations for Ontario lands).

iii) Increase core size of each Potential Conservation Area to a minimum of 100 acres (40 hectares) with a 300 foot (91 meter) buffer.

2-b. Increase connectivity between Potential Conservation Area's, with a particular emphasis on the Great Lakes marsh system.

i) Establish natural connections among 50% of existing Potential Conservation Area's, using the following guidelines

- 1.2 kilometers (.75 miles) width to provide interior habitat
- 100 – 1,000 m width is considered best
- Strive for shortest distance (least cost)
- Follow riparian corridors
- Focus on Great Lakes marsh transition zone
- Utilize areas with existing natural lands

ii) Restore at least two areas of barrier free connectivity between Great Lakes marsh, lakeplain prairie and lakeplain oak opening (Great Lakes marsh system)

iii) Establish 100 m buffers along 75% of all riparian zones (Environment Canada, 2004).

Due to the high degree of fragmentation and landscape modification, there is a critical need for improving the connectivity of fragmented ecosystems and landscapes in the project area. This is particularly true for all of the components of the Great Lakes marsh ecosystem from the submergent zone to the shrub-carr zone throughout its historical aerial extent on the landscape, including the various lakeplain prairie types as well as lakeplain oak openings. As mentioned earlier, the lateral movement of the marsh complex inland during high water periods and lakeward during low water periods is critical to the long term health of the system. The development of roads, dikes, structures, channels and seawalls creates a "pinching effect" on the marsh and decreases its ability to regenerate after disturbance (resiliency).

HIGHLIGHT

There is a critical need for improving the connectivity of fragmented ecosystems and landscapes.

FACT

Connectivity should also include hydrologic connectivity – the natural movement of water throughout the system.

Increased connectivity with the Great Lakes marsh system leads to larger wetlands and habitat diversity which improves waterfowl productivity, provides larger staging areas during migration, and increases overall biological diversity. Connectivity should also include hydrologic connectivity – the natural movement of water throughout the system. This natural movement of water provides oxygen to help breakdown dead organic matter allows for movement of aquatic organisms such as fish and allows for the natural development of new environments. Restoration efforts should really focus on the reintegration of the entire Great Lakes marsh complex where possible in order to improve ecological integrity at the landscape scale.

Tools:

Potential Conservation Area data layer *(see Section VII)*
Integrated Coastal Management Tool *(See Section VII)*

3) Manage Widespread Threats/Stressors

3-a. Maintain and restore a high degree of both surface and ground water quality.

i) Provide buffers along all rivers and streams (>100 meters; 328 feet)
ii) Restore wetlands (minimum 10% of original acreage or equivalent hectares)
iii) Restore upland buffers around all wetlands (>300 meters; 984 feet)
iv) Protect vulnerable wellhead protection areas (if defined)
v) Protect shallow aquifer recharge areas (if defined)
vi) Protect headwaters of rivers and streams

No restoration plan can be truly successful if it does note address threats. A group can plant thousands of bulrush plugs, but if they do not address threats to the site they are restoring such as boat activity, water pollution, or beach grooming, their efforts will be fruitless. Many threats can and should be addressed at the site level. However, some threats seem to occur throughout the landscape. These are stressors that will continue to defeat the best restoration efforts if they are not treated at a larger scale. Examples of Hwidespread threats include: urban development, invasive species, altered hydrology, water pollution (point and non-point), air pollution, recreational boating and shipping. Section V of this document discusses these stressors in depth and identifies existing programs to address them.

HIGHLIGHT

The Potential Conservation Areas that were identified within the project area and ranked as part of this Assessment in Section VII provide an ideal starting point.

Application of GIS tools holds particular promise to help address threats posed by non-point source water pollution. The Integrated Coastal Management tool discussed in Section VII of this document can be used to identify particular habitat types (e.g., riparian) within the Lake St. Clair study area that are especially vulnerable (e.g., with little or no vegetative cover) to pollution threats and help prioritize areas for remedial action, such as revegetation.

Tools:

- Lake St. Clair Integrated Coastal Management (ICM) Tool *(See Section VII)*
- Hydrology GIS layer
- Circa 1800 vegetation GIS layer
- Wetlands GIS layer
- Wellhead locations
- Sensitive groundwater recharge area GIS layer

4) Assess Current Management and Status

When conceptual concerns have been adequately addressed, it is critical to identify the current management and protection status of the lands that have been targeted for protection and/or restoration. Are they privately held and ripe for development? Might the owner consider a conservation easement to preserve them in their natural state? Are they already owned by the state or a local municipality? The Potential Conservation Areas (PCAs) that were identified within the project area and ranked as part of this Assessment in Section VII provide an ideal starting point. These lands may be protected by a number of mechanisms: as designated natural areas, proposed natural areas, through state ownership, county ownership, township ownership, city/town ownership, conservation easements, farm bill program enrollment, local natural features ordinances, etc. These and other existing land management programs that may already offer some level of protection to natural lands are described in detail in Section VI of this Assessment.

HIGHLIGHT

Widespread threats include: urban development, invasive species, altered hydrology, water pollution, air pollution, recreational boating and shipping.

Each area that is not currently protected should be identified and evaluated to determine the mechanism that would protect it most effectively. In terms of priority, not all natural features are created equally. Some areas may not be suitable for inclusion in the pool of potential conservation lands due to incompatible adjacent land uses, high financial cost, contamination, etc.

Important questions to consider include:

- Who owns the lands?
- Who should own the land to protect it in perpetuity?
- What resources are available to protect or restore the land?
- Who will spearhead a particular purchase/protection/restoration effort?
- Who will "sell" the vision so that it is actually implemented?

Conclusion

The purpose of this chapter is to provide a framework for determining how to best conserve and restore natural habitats and biodiversity within the Lake St. Clair coastal area. In a highly fragmented landscape, determining and prioritizing conservation targets can sometimes be a very simple exercise, particularly if the scientific information is accurate, current and comprehensive. However, if the goal is to go beyond protecting the small remaining fragments and instead ensure the long term viability of existing biota and possibly even reestablish plant and animal species and ecological processes that have long disappeared from this landscape, the process can be rather complicated. To simplify this process, the recommendations developed for this project focus on three primary areas: 1) maintain and restore adequate representation of native biodiversity, 2) maintain and restore landscape integrity (the supporting landscape) and 3)

manage widespread threats and stresses. This section provides a conceptual framework for setting goals, objectives and targets. Specific actions under each recommendation provide a reasonable starting point for making sometimes difficult conservation planning decisions, which can be tailored to each community within the project area.

Section VIII Endnotes

1. Constanza, R., R. d'Arge, R. de Groot, S. Farber, M. Grasso, B. Hannon, K. Limberg, S. Naeem, R. V. O'Neill, J. Paruelo, R. G. Raskin, P. Sutton, M. van den Belt. 1997. The value of the world's ecosystem services and natural capital. *Nature*. May, 1997. Vol. 387.

2. Daily, G.C. (ed.) 1997 Nature's Services: Societal Dependence on Natural Ecosystems. Island Press, Washington D.C.

3. Public Sector Consultants, Inc. 2001. *Michigan Land Resource Project*. Lansing, MI

4. Porter, Douglas R. (2002) Making Smart Growth Work. Urban Land Institute, Washington D.C.

5. Stanford Environmental Law Journal,. Volume 20, No. 2, May, 2001. Sandford Law School, Stanford, CA 94305-8610. ISSN 0892-7138.

6. Appel, LM, Craves, JA, Smith, MK, Weir, B, & Zawiskie, JM, 2004. Explore Our Natural World: A Biodiversity Atlas of the Lake Huron to Lake Erie Corridor. Funded by the USEPA through a grant to Wildlife Habitat Council.

7. Noss R F and AY Cooperrider. 1994. Saving Nature's Legacy: Protecting and resotring biodiversity. Island Press, Washington, D. C.

8. Armstrong, J.K. 1993. *Restoration of function or diversity*. Pp. 209-14 in Nature Conservation III: Reconstruction of Fragmented Ecosystems ed. by DA Saunders, RJ Hobbs, and PR Ehrlich. Surrey Beatty & Sons: Perth.

9. Daily, G.C. (ed.) 1997 Nature's Services: Societal Dependence on Natural Ecosystems. Island Press, Washington D.C.

10. Parrish J.D.; Braun D.P.; Unnasch R.S., 2003. Are We Conserving What We Say We Are? Measuring Ecological Integrity within Protected Areas. BioScience, vol. 53, no. 9, pp. 851-860(10).

11. The Nature Conservancy. 1996. *Conservation by design: a framework for mission success*. The Nature Conservancy, Arlington, VA.

12. Parrish JD; Braun DP; Unnasch RS, 2003. Are we conserving what we say we are? Measuring Ecological Integrity within Protected Areas. BioScience, 53:9, pp.851-860

13. Noss R F and AY Cooperrider. 1994, *op. cit*.

14. Poiani, Karen. A, Brian D. Richter, Mark G. Anderson and Holly E. Richter. 2000. Biodiversity conservation at multiple scales: functional sites, landscapes and networks. BioScience 50: 133-146.

15. Anderson, M.G., Comer, P., Grossman, D., Groves, C., Poiani, K., Reid, M., Schneider, R., Vickery, B. and A. Weakley. 1999. Guidelines for representing ecological communities in ecoregional conservation plans. The Nature Conservancy. 74 pp.

16. Anderson et al., 1999, *op. cit*.

17. Lambeck, R.J. 1997. Focal species: A multi-species umbrella for nature conservation. Conservation Biology 11:849-856.

18. Society for Ecological Restoration International Science & Policy Working Group, 2004. *The SER International Primer on Ecological Restoration*. www.ser.org & Tucson: Society for Ecological Restoration International.

19. Society for Ecological Restoration International Science & Policy Working Group, 2004, *op.cit*.

20. Coastal Change Analysis Program (C-CAP), National Oceanic and Atmospheric Administration, Coastal Services Center, Charleston, South Carolina, 2003.

21. Society for Ecological Restoration International Science & Policy Working Group, 2004, *op.cit*.

22. *Ibid*.

23. NatureServe, 2002. Element Occurrence Data Standard. Accessed 28 January 2005: http://whiteoak.natureserve.org/eodraft/all.pdf

24. Coastal Change Analysis Program (C-CAP), National Oceanic and Atmospheric Administration, Coastal Services Center, Charleston, South Carolina, 2003.

APPENDIX A.

LAKE ST. CLAIR COASTAL HABITAT PROJECT MANAGEMENT TEAM

FEDERAL AGENCIES

Tameka Dandridge
Wildlife Biologist
U.S. Fish & Wildlife Service
E. Lansing, MI 48823
Phone: 517-351-8315
Fax: 517-351-1443
Tameka_Dandridge@fws.gov

Rose Ellison
Environmental Scientist
U.S. Environmental Protection Agency
9311 Groh Road
Grosse Ile, Michigan 48138
Phone: 734-692-7689
Fax: 734-692-7677
Ellison.Rosanne@epa.gov

Sandra George
Restoration Programs Division
Environment Canada
867 Lakeshore Road
Burlington. Ontario L7R 4A6
Phone: 905-336-6284
Fax: 905-336-6272
sandra.e.george@ec.gc.ca

Tonya K. Harrington
Regional Economist
Plan Formulation Branch, Planning Division
U.S. Army Corps of Engineers - Detroit District
477 Michigan Ave
P.O. Box 1027
Detroit, MI 48231-1027
Phone: 313-226-3637
Fax: 313-226-7095
tonya.k.harrington@lre02.usace.army.mil

Albert Jones
Assistant State Conservationist for Field Operations
Natural Resources Conservation Service
USDA
3001 Coolidge Rd., Suite 250
East Lansing, MI 48823
Phone: 517-324-5270
Fax: 517-324-5171
albert.jones@mi.usda.gov

Colette Luff
Detroit District
U.S. Army Corps of Engineers
477 Michigan Ave.
P.O. Box 1027
Detroit, MI 48231-1027
Phone: 313-226-7485
Fax: 313-226-7095
colette.M.luff@usace.army.mil

Dora R. Passino-Reader, Ph.D.
Fishery Biologist
USGS, Great Lakes Science Center
1451 Green Road, Ann Arbor, MI 48105
Phone: 734-214-7229
Fax: 734-994-8780
dora_reader@usgs.gov

Norm Smith
Impact Assessment Biologist
Ontario Great Lakes Area
Central and Arctic Region
Fisheries and Oceans Canada
703-201 Front St. North
Sarnia, ON N7T 8B1
Phone: 519-383-1815
Fax: 519-383-0699
smithnw@dfo-mpo.gc.ca

NOAA

Jeff Adkins
Economist
Landscape Characterization and Restoration
NOAA - Coastal Services Center
2234 S. Hobson Avenue
Charleston, SC 29405-2413
Phone: 834-740-1244
Fax: 834-740-1315
jeffery.adkins@noaa.gov

Alyssa Olson Callahan
Environmental Scientist II
Technology Planning and Management Corp
NOAA Coastal Service Center
2234 South Hobson Avenue
Charleston, SC 29405-2413
Phone: 843-740-1219
Alyssa.Olson-Callahan@noaa.gov

Robert P. McGuinn
Physical Scientist
Landscape Characterization and Restoration
Technology Planning and Management Corporation
(TPMC)
NOAA Coastal Services Center
2234 Hobson Ave.
Charleston, SC 29405-2413
Phone: 843-740-1269
Fax: 843-740-1315
Robert.McGuinn@noaa.gov

STATE AGENCIES

Roger Eberhardt
Office of the Great Lakes
MI DEQ
P.O. Box 20473
Lansing, MI 48909-7973
Phone: 517-335-7927
Fax: 517-335-4053
eberharr@michigan.gov

Dave Kenaga
Land and Water Management Division
Michigan Coastal Management Program
MI DEQ
Constitution Hall
525 West Allegan Street, P.O. Box 30458
Lansing, MI 48909-3451
Phone: 517-335-3449
Fax: 517-241-0858
kenagad1@mi.gov

Ernie Kafcas
Wildlife
MI DNR
33135 S. River Road
Harrison Twp., MI 48045
Phone: 586-465-7214
Fax: 586-465-7504
kafcase@michigan.gov

Kurt Newman
Lake Erie Basin Coordinator
Fisheries Division
MI DNR
Stevens T. Mason Bldg.
P.O. Box 30446
Lansing, MI 49735
Phone: 517-241-3623
Fax: 517-373-0381
newmankr@michigan.gov

Greg Soulliere
Wetland and Waterfowl Specialist
DNR Wildlife Division
Michigan DNR
P.O. Box 30444
Lansing, MI 48909-7944
Phone: 517-241-3451
soullieg@michigan.gov

Mike Thomas
Fisheries Division
MI DNR
33135 South River Road
Mount Clemons, MI 48045
Phone: 586-465-4771
Fax: 586-465-7504
thomasmv@michigan.gov

PROVINCIAL AGENCIES

Brian Potter
Aquatic Ecologist - Wetlands
Conservation and Planning Section
Ontario Ministry of Natural Resources
300 Water Street, 5th Floor, South Tower
Peterborough, ON K9J 8M5
Phone: 705-755-1917
Fax: 705-755-1259
brian.potter@mnr.gov.on.ca

Wasyl D. Bakowsky
Community Ecologist
Natural Heritage Information Centre, OMNR
300 Water Street, 2nd Floor, North Tower
Peterborough, Ontario
K9J 8M5
Phone: 705-755-2162
Fax:705.755.2168
wasyl.bakowsky@mnr.gov.on.ca

LOCAL AGENCIES

Geoffrey Donaldson
Environmental Planner
St. Clair County Metropolitan Planning Commission
200 Grand River, Suite 202
Port Huron, MI 48060
Phone: 810-989-6950 x 6228
Fax: 810-987-5931
gdonaldson@stclaircounty.org

Doug Martz, Chairman
Macomb County Water Quality Board
38217 Cherry Lane
Harrison Township, MI 48045
Phone: 586-463-8263
Fax: 586-469-6636
channelkeeper@mindspring.com

Bill Parkus
Southeast Michigan Council of Governments
535 Griswold, Suite 300
Detroit, MI 48226
Phone: 313-324-3351
Fax: 313-961-4869
parkus@semcog.org

Mark Richardson
Asst Prosecutor for Water Quality
Macomb County Prosecutor's Office
One South Main St. 3rd. Flr.
Mt. Clemens, MI 48043
Phone: 586-469-5593
Fax: 586-469-5609
Mark.Richardson@macombcountymi.gov

Gerard P. Santoro, AICP
Senior Planner
Department of Planning and Economic Development
Macomb County
1 South Main Street, 7th Floor
Mount Clemens, Michigan 48043
(586) 469-6443 Ph, 469-6787 Fax
gerard.santoro@co.macomb.mi.us

GREAT LAKES COMMISSION (SECRETARIAT)

Victoria Pebbles
Great Lakes Commission
Eisenhower Corporate Park
2805 South industrial Hwy., Suite 100
Ann Arbor, MI 48104-6791
Phone: 734-971-9135
Fax: 734-971-9150
vpebbles@glc.org

Tom Rayburn
Great Lakes Commission
Eisenhower Corporate Park
2805 South industrial Hwy., Suite 100
Ann Arbor, MI 48104-6791
Phone: 734-971-9135
Fax: 734-971-9150
tray@glc.org

CONSERVATION AUTHORITIES

Jerry Campbell
General Manager
Lower Thames Conservation Authority
100 Thames Street
Chatham, ON N7L 2Y8
Phone: 519-354-7310
Fax: 519-352-3435
LTVCA@mnsi.net

Matthew Child
Coordinator
Habitat & Aquatic Resources Services
Essex Region Conservation Authority
360 Fairview Avenue West
Essex, ON N8M 1Y6
Phone: 519-776-5209 x 368
Fax: 519-776-8688
mchild@erca.org

TRIBES/FIRST NATIONS

Dean Jacobs
Executive Director
Walpole Island Heritage Centre
Wallaceburg. ON N8A 4K9
Phone: 519-627-1475
Fax: 519-627-1530
dmjacobs@ciaccess.com

NON/PROFIT ORGANIZATIONS

Russ Terry
Great Lakes/ Atlantic Region
Ducks Unlimited
331 Metty Drive, Suite 4
Ann Arbor, MI 48103
Phone: 734-623-2000
Fax: 734-623-2035
rterry@ducks.org

Lisa Appel
Pine River Nature Center
499 Range Road
Port Huron, MI 48061
Phone: 810-364-8990
Fax: 810-364-7474
lappel@stclair-isd.k12.mi.us

Dave West
Ducks Unlimited Canada
566 Welham Road
Barrie, Ontario L4N 8Z7
Phone: 705-721-4444
Fax: 705-721-4999
d west@ducks.ca

Andrea Kline
Project Director
The Nature Conservancy
101 E. Grand River
Lansing, MI 48906
Phone: 517-316-0300
Fax: 517-316-9886
akline@tnc.org

ACADEMIC INSTITUTIONS

George R. Carignan
Interim Director
Michigan Sea Grant College Program
University of Michigan
2200 Bonisteel Boulevard
Ann Arbor, MI 48108-2099
Phone: 734-615-4084
Fax: 734-936-4391
carignan@engin.umich.edu

John Paskus
Conservation Planning Specialist
Michigan Natural Features Inventory
Michigan State University Extension
P.O. Box 30444
Lansing, MI 48909-1552
Phone: 517-335-3973
Fax: 517-373-9566
paskusj@michigan.gov

Appendix B.

Lake St. Clair Coastal Habitat Advisory Committee

Muriel Andreae
Biologist
St. Clair Region Conservation Authority
205 Mill Pond Cres.
Strathroy, ON N7G 3P9
Phone: 519-245-3710 x 122
Fax: 519-245-3348
mandreae@scrca.on.ca

Alison Horton
Director
Mackinac Chapter
Sierra Club
109 East Grand River
Lansing, MI 48906

Hugh Horton
Detroit Audubon Society
29474 Old North River Road
Harrison Township, MI 48045

Andrea Kline
The Nature Conservancy
101 E. Grand River
Lansing, MI 48906
Phone: 517-316-0300
Fax: 517-316-9886
akline@tnc.org

Laura Lodisio
Focus Area Team Leader
Midwest Natural Resources Group
U.S. EPA
77 West Jackson Blvd.
Chicago, IL 60604

Michael K. O'Bryan, P.E.
Chief, Engineering and Technical Services
Department of the Army
Detroit, District, Corps of Engineers
Box 1027
Detroit, MI 48231-1027

Jessica Pitelka Opfer
Clinton River Watershed Council
101 Main Street, Suite 100
Rochester, MI 48307
Phone: 248-601-0606
Fax: 248-601-1280
jessica@crwc.org

Art Ostaszewski
Stormwater and Remedial Action Unit
Surface Water Quality Division
Michigan Dept. of Environmental Quality
P. O. Box 30273
Lansing, MI 48909
Phone: 517-335-1119
Fax: 517-373-2040
ostaszea@state.mi.us

John Perrecone
Critical Ecosystems Team
U.S. EPA, Region 5
77 West Jackson Blvd.
Chicago, IL 60604
Phone: 312-353-1149
perrecone.john@epa.gov

Karen M. Rodriguez
G-17J
U.S. EPA Region 5
77 West Jackson Blvd
Chicago, IL 60604-3507
Phone: 312-353-2690
rodriguez.karen@epa.gov

Dolly Schenk
Director
River of Life
Clinton River Watershed Project
P.O. Box 311
Clarkston, MI 48347-0311
Phone: 248-394-0389
Fax: 248-394-1118
DEARSCHECNK@aol.com

Frank Schoonover
Harsen's Island St. Clair Flats Association
3240 South Channel Dr.
Harsen's Island, MI 42028:

William E. Smith
Clinton River Area of Concern Public Advisory Council
49 Breitmeyer Place
Mt. Clemens, MI 48043

Bud West
Acting President
Friends of the St. Clair River
949 Kemsley Drive
Sarnia, ON N7V 2M9

Patricia Chow-Fraser
Department of Biology
McMaster University
1280 Main Street, West
Hamilton, ON L8S 4K1
Phone: 905-525-9140 x 27339
Fax: 905-336-6437
chowfras@mcmaster.ca

Michigan
Natural
Features
Inventory

MICHIGAN STATE
UNIVERSITY
EXTENSION